This document gives pertinent information concerning the reissuance of the VPDES Permit listed below. This permit is being processed as a **Minor, Municipal** permit. The discharge results from the operation of a 0.0395 MGD wastewater treatment plant with a proposed expansion to a design flow tier of 0.0495 MGD. This permit action consists of updating the proposed effluent limits to reflect the current Virginia WQS (effective January 6, 2011) and updating permit language as appropriate. The effluent limitations and special conditions contained in this permit will maintain the Water Quality Standards of 9VAC25-260 et seq.

1. Facility Name and Mailing Address: Madeira School, 8328 Georgetown Pike, McLean, VA 22102 — SIC Code: 4952 (WWTP), 8211 (School)

   Facility Location: 8328 Georgetown Pike, McLean, VA 22102 — County: Fairfax

   Facility Contact Name: Braughn Taylor — Telephone Number: 703-556-8245

   Facility E-mail Address: btaylor @madeira.org

2. Permit No.: VA0024121 — Expiration Date of previous permit: 11/9/2013

   Other VPDES Permits associated with this facility: VAN010124 (Nutrient General Permit)

   Other Permits associated with this facility: Air Registration No. 71828, Waste EPA ID VAD988197919, Petroleum 3008826

   E2/E3/E4 Status: NA

3. Owner Name: The Madeira School

   Owner Contact/Title: Braughn Taylor — Telephone Number: 703-556-8245

   Owner E-mail Address: btaylor @madeira.org

4. Application Complete Date: 4/29/2013

   Permit Drafted By: Anna Westernik — Date Drafted: 10/29/2013

   Draft Permit Reviewed By: Alison Thompson — Date Reviewed: 11/05/2013

   WPM Review By: Bryant Thomas — Date Reviewed: 11/15/2013

   Public Comment Period: Start Date: 1/9/2014 — End Date: 2/7/2014

5. Receiving Waters Information: The drainage area at Outfall 001 is 0.0455 $mi^2$. Therefore, critical flow values are zero.

| | | | |
|---|---|---|---|
| Receiving Stream Name: | Difficult Run, UT | Stream Code: | 1aXGF |
| Drainage Area at Outfall: | 0.0455 $mi^2$ | River Mile: | 0.2 |
| Stream Basin: | Potomac River | Subbasin: | Potomac |
| Section: | 8 | Stream Class: | III |
| Special Standards: | PWS | Waterbody ID: | VAN-A11R |
| 7Q10 Low Flow: | 0.0 MGD | 7Q10 High Flow: | 0.0 MGD |
| 1Q10 Low Flow: | 0.0 MGD | 1Q10 High Flow: | 0.0 MGD |
| 30Q10 Low Flow: | 0.0 MGD | 30Q10 High Flow: | 0.0 MGD |
| Harmonic Mean Flow: | 0.0 MGD | 30Q5 Flow: | 0.0 MGD |

6. Statutory or Regulatory Basis for Special Conditions and Effluent Limitations:

- ✓ State Water Control Law
- ✓ Clean Water Act
- ✓ VPDES Permit Regulation
- ✓ EPA NPDES Regulation
- ✓ EPA Guidelines
- ✓ Water Quality Standards (VA and MD)
- ✓ Other

9VAC25-820 et seq. – *Nutrient Watershed General Permit*
9VAC25-720 et seq. – *Water Quality Management Plan Regulation*
9VAC25-40 et seq. – *Regulation for Nutrient Enriched Waters and Dischargers within the Chesapeake Bay Watershed*
*Dulles Policy (9VAC25-401)*

7. Licensed Operator Requirements: Class III

8. Reliability Class: Class I

9. Permit Characterization:

| | | |
|---|---|---|
| ✓ Private | ✓ Effluent Limited | ✓ Possible Interstate Effect |
| Federal | ✓ Water Quality Limited | Compliance Schedule Required |
| State | Whole Effluent Toxicity Program Required | Interim Limits in Permit |
| POTW | Pretreatment Program Required | ✓ Interim Limits in Other Document (Consent Order dated 3/17/06) |
| ✓ TMDL | | |

**10. Wastewater Sources and Treatment Description:**

Wastewater flows via gravity to an influent lift station from where it is pumped to the wastewater treatment plant headworks. Primary treatment consists of removal of debris by a mechanical or manual bar screen. Liquid soda ash is added prior to sewage flow into an equalization tank. Flow from the equalization tank is metered at a controlled rate into the aeration basins.

The aeration system consists of two treatment trains each having five separate extended aeration activated sludge processing tanks connected to one another; the treatment trains are constructed to operate both in series and parallel. Following activated sludge treatment, the biomass is settled and returned back to the activated sludge system. Wastewater from a clarifier that follow secondary treatment is routed to tertiary sand filters for final polishing and then sent through an ultraviolet (UV) disinfection system and flow meter prior to discharge into an unnamed tributary of Difficult Run. When the design flow is expanded to 0.0495 MGD, filtered water will then be routed through a denitrification filtration unit prior to disinfection. Grab samples are collected after UV disinfection and composite samples are collected at the outfall.

The outfall location has been moved 1,000-1,500 feet upstream of the former discharge location for Outfall 001. The unnamed tributary appears to be an intermittent stream with possible groundwater influence from a location on the Madeira School property. The unnamed tributary at the discharge location consists of approximately a 50:50 pool and riffle ratio. The stream meanders and travels for approximately 0.19 miles before discharging to the Potomac River.

See **Attachment 1** for a facility schematic/diagram.

| TABLE 1 – Outfall Description | | | | |
|---|---|---|---|---|
| **Outfall Number** | **Discharge Sources** | **Treatment** | **Design Flows** | **Outfall Latitude and Longitude** |
| 001 | Domestic Wastewater | See Item 10 above. | 0.0395 MGD<br>0.0495 MGD (expansion) | 38° 58' 18.6" N<br>77° 14' 07.4" W |
| See **Attachment 2** for Falls Church topographic map (#204D). | | | | |

**11. Sludge Treatment and Disposal Methods:**
Sludge wasted from this treatment works is stored in a holding tank prior to disposal at the UOSA WWTP in Centreville, Virginia. Hauling is conducted Monday through Friday 8:00 a.m. to 5:00 p.m.

**12. Discharges, Intakes, Monitoring Stations, Other Items in Vicinity of Discharge**

| TABLE 2<br>DISCHARGES WITHIN WATERBODY VAN-A11R | | | |
|---|---|---|---|
| **Individual VPDES Permits Discharging to Waterbody VAN-A11R** | | | |
| **Description** | **Type** | **Latitude/ Longitude** | **Rivermile** |
| VA0090093 -- John Marshall III Site | 0.017 MGD Industrial Discharge from a Groundwater Remediation System | 38° 55' 17";<br>77° 13' 56" | Spring Branch |
| VA0091995 -- Reston Lake Anne Air Conditioning Corporation | Industrial Discharge | 38° 57' 54";<br>77° 20' 15" | Lake Anne |
| General Permits Discharging to Waterbody VAN-A11R | | | |
| **Single Family Homes** | | | |
| **Permit Number** | **Facility Name** | **Receiving Stream** | |
| VAG406098 | Groark Edward C Residence | Bullrun Neck, UT | |
| **Car Wash** | | | |
| **Permit Number** | **Facility Name** | **Receiving Stream** | |
| VAG750193 | Avis Rent A Car | Scott Run, UT | |
| **Petroleum** | | | |
| **Permit Number** | **Facility Name** | **Receiving Stream** | |
| VAG830246 | Vienna 226 Maple Venture, LLC | Piney Branch | |
| VAG830381 | Reston Community Center | Snakeden Branch | |
| VAG830194 | Texaco *230681318* -- Vienna Food Mart | Piney Branch | |
| **Cooling Water** | | | |
| **Permit Number** | **Facility Name** | **Receiving Stream** | |
| VAG250102 | The Peterson Companies | Scotts Run, UT | |

**13. Material Storage:**

Approximately 500 pounds of bagged soda ash is stored on pallets under roof to assist with nitrification.

**14. Site Inspection:**

Performed by Anna Westernik on July 1, 2013 (see **Attachment 3**).

**15. Receiving Stream Water Quality and Water Quality Standards:**

a) Ambient Water Quality Data

This facility discharges into an unnamed tributary to Difficult Run (1aXGF). There is no DEQ water quality monitoring station on this unnamed tributary. The nearest DEQ monitoring station is 1aDIF000.86, which is located on Difficult Run at the Route 193 bridge crossing. This station is located upstream from where the Unnamed Tributary (XGF) enters Difficult Run. However, 1aDIF000.86 is used to assess the water quality on Difficult Run at the confluence with the unnamed tributary, 1aXGF. Station 1aDIF000.86 is located approximately 0.88 rivermiles from Outfall 001. The following is the water quality summary for this portion of Difficult Run, as taken from the Draft 2012 Integrated Assessment:

Class III, Section 8, special standards PWS.

DEQ ambient, biological, and sediment monitoring station 1aDIF000.86, at Route 193, biological monitoring station 1aDIF000.80, downstream of Route 193. USGS gage station 016246000. Citizen monitoring station 1aDIF-DR34-SOS.

The fish consumption use is categorized as impaired due to a Virginia Department of Health, Division of Health Hazards Control, PCB fish consumption advisory and for heptachlor epoxide based on fish tissue monitoring. The impairment for the fish consumption use based on heptachlor epoxide in fish tissue was first listed in 2006 and will continue to stand as there has been no additional data collected for this parameter. Additionally, there was an exceedence of the water quality criterion based tissue value (TV) of 300 ppb for mercury in American eel (2004), and an exceedence of the water quality criterion based tissue value (TV) of 110 ppb for total chlordane in American eel (2004), both of which are noted by an observed effect for the fish consumption use.

Biological monitoring finds a benthic macroinvertebrate impairments, resulting in an impaired classification for the aquatic life use. Additionally, the data collected by the citizen monitoring group indicate that a water quality issue may exist; however, the methodology and/or data quality has not been approved for such a determination. Citizen monitoring finds a medium probability of adverse conditions for biota. A benthic TMDL has been completed and approved for Difficult Run.

The recreation, public water supply and wildlife uses are considered fully supporting.

b) 303(d) Listed Stream Segments and Total Maximum Daily Loads (TMDLs)

TABLE 3 – WATER QUALITY IMPAIREMENTS

| Waterbody Name | Impaired Use | Cause | Distance From Outfall | TMDL completed | WLA | Basis for WLA | TMDL Schedule |
|---|---|---|---|---|---|---|---|
| ***Impairment Information in the 2012 Integrated Report*** | | | | | | | |
| Difficult Run | Aquatic Life | *Benthic Macroinvertebrates: Sediment* | 0.2 miles | Yes | 2.3 tons/year of sediment | Max Permitted Design Flow (0.0495 MGD) and TSS Concentration (30 mg/L) | Completed in 2008 |
| | Fish Consumption | *PCBs in Fish Tissue* | 0.2 miles | No | NA | NA | 2018 |
| | Fish Consumption | Heptachlor Epoxide | 0.2 miles | No | NA | NA | 2018 |
| | Recreation* | *E. coli* | 0.2 miles | Yes | 8.62E+10 cfu/year | Max Permitted Design Flow (0.0495 MGD) and *E. Coli* criterion of 126 cfu/100mL | 2008 |

*The recreation use impairment for this portion of Difficult Run was delisted in the 2012 Draft Integrated Assessment. Even though this portion of the stream has been delisted for E. coli, the WLA for this facility remains in effect.

Table 3 above notes the presence of PCB and heptachlor impairments in Difficult Run. However, DEQ Staff has concluded that low-level PCB and heptachlor monitoring is not warranted for this facility since it is a small wastewater treatment facility that is unlikely to discharge any PCBs and heptachlor.

Difficult Run has completed sediment and bacteria TMDLs. This facility is addressed in both of these TMDLS; the allowable concentrations of TSS and bacteria that can be discharged are addressed through this permit.

Significant portions of the Chesapeake Bay and its tributaries are listed as impaired on Virginia's 303(d) list of impaired waters for not meeting the aquatic life use support goal, and the 2010 Virginia Water Quality Assessment 305(b)/303(d) Integrated Report indicates that much of the mainstem Bay does not fully support this use goal under Virginia's Water Quality Assessment guidelines. Nutrient enrichment is cited as one of the primary causes of impairment. EPA issued the Bay TMDL on December 29, 2010. It was based, in part, on the Watershed Implementation Plans developed by the Bay watershed states and the District of Columbia.

The Chesapeake Bay TMDL addresses all segments of the Bay and its tidal tributaries that are on the impaired waters list. As with all TMDLs, a maximum aggregate watershed pollutant loading necessary to achieve the Chesapeake Bay's water quality standards has been identified. This aggregate watershed loading is divided among the Bay states and their major tributary basins, as well as by major source categories (wastewater, urban storm water, onsite/septic agriculture, air deposition). Fact Sheet Section 17.d. provides additional information on specific nutrient limitations for this facility to implement the provisions of the Chesapeake Bay TMDL.

The full planning statement is found in **Attachment 4.**

c) Receiving Stream Water Quality Criteria

Part IX of 9VAC25-260(360-550) designates classes and special standards applicable to defined Virginia

river basins and sections. The receiving stream, Difficult Run, UT, is located within Section 8 of the Potomac River Basin and is a Class III water.

At all times, Class III waters in the Commonwealth of Virginia must achieve a dissolved oxygen (D.O.) of 4.0 mg/L or greater, a daily average D.O. of 5.0 mg/L or greater, a temperature that does not exceed 32°C and maintain a pH of 6.0-9.0 standard units (S.U.). The Maryland Water Quality Criteria Specific to Designated Uses (Code of Maryland Regulations 26.08.02.03-3.A) for Use I Waters (Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life) states that a pH of 6.5-8.5 must be maintained. Per this regulation, Maryland Use I Waters must also achieve a D.O. of 5.0 mg/L or greater and a temperature that does not exceed 32°C.

1) Ammonia:
The 7Q10 and 1Q10 of the receiving stream are 0.0 MGD. In cases such as this, effluent pH and temperature data may be used to establish the ammonia water quality standard. See **Attachment 5** for the derivation of the 90$^{th}$ percentile values of the effluent pH and temperature data from January 2011 to December 2012. The 90$^{th}$ percentile pH value for this period (7.98 S.U.) differs significantly from that used for the 2008 permit reissuance (8.4 S.U.); whereas, the 90$^{th}$ percentile temperature value of 24.6°C derived from January 2011 to December 2012 data and the 90$^{th}$ percentile temperature value of 25°C used in the 2008 permit reissuance are statistically similar. The January 2011 through December 2012 data and a default winter temperature value of 15 °C is shall be used to determine ammonia criteria for this permit reissuance.

Due to the proximity of the discharge to the Maryland State line (approximately 0.19 miles), Maryland Water Quality Criteria were examined (see Table 4 below). Maryland freshwater criteria were determined using the effluent pH of 8.0 (due to the domination of effluent in the receiving stream) and a temperature value of 24° C.

The Virginia acute ammonia criteria (8.7 mg/L) do not concur with the Maryland acute criteria of 64 mg/L (salmonids absent). The Virginia and Maryland chronic criteria (no early life stages present) were found to be similar. The more stringent Virginia Water Quality Criteria for ammonia shall be used to determine permit limits.

TABLE 4 – Ammonia Criteria

| | VA Freshwater (mg/L) | MD Freshwater (mg/L)* |
|---|---|---|
| **Annual Acute** | 8.73 | 64 |
| **Annual Chronic** | 1.31 | 1.32 |

*Per Title 26 of the Department of the Environment, Subtitle 08 Water Pollution, Chapter 02 Water Quality, .03-1 Toxic Substance Water Quality Criteria for Surface Waters.

2) Metals Criteria:

a. Metals Criteria (except Copper):
The Water Quality Criteria for some metals are dependent on the receiving stream's hardness (expressed as mg/L calcium carbonate). Since the 7Q10 and 1Q10 of the receiving stream are zero, the effluent data for hardness can be used to determine the metals criteria. The hardness-dependent metals criteria found in **Attachment 6** are based on an average effluent value of 143 mg/L derived from the effluent data collected for the Water Effects Ratio (WER) Study on April 3, 2012 (140 mg/L) and May 21, 2012 (146 mg/L). The criteria shown in **Attachment 6** are protective of the Maryland freshwater criteria since they are determined using the same methodology as Virginia freshwater criteria.

b. Copper Criteria and the WER Study:
In the process of reissuing the 2008 VPDES permit, DEQ determined that limits were necessary for total recoverable copper. Monitoring and a schedule of compliance were included in the 2008 VPDES permit. **Attachment 7** is a summary of the copper monitoring data from March 2009 to September 2013.

During the previous permit cycle, the facility has reported exceedences of the proposed total recoverable copper limitations and was referred to DEQ-NRO Enforcement. As part of the Consent Special Order dated December 14, 2011 (see **Attachment 8** for Appendix A, Schedule of Compliance), the Madeira School pursued a WER streamlined study for copper. The study followed EPA guidance for a Streamlined Water Effect Ratio Procedure for the Discharges of Copper (EPA 822-R-01-05). The Final Streamlined WER Report was submitted to DEQ on October 29, 2012. DEQ's Water Quality Standards Staff reviewed the submitted document in January 2013. The Final Streamlined WER Report and the DEQ review memorandum dated January 24, 2013 can be found in **Attachment 9**. A summary of the calculated copper water quality criteria is discussed below.

Per 9VAC25-260-140.F, the formulas for the freshwater acute and chronic criteria (µg/L) for copper utilize a default WER value of 1.0 unless shown otherwise.

Acute Criteria

$$WER \times [e^{\{0.9422[\ln(hardness)]-1.700\}}] \times (CF_a)$$
Where $CF_a = 0.96$

Chronic Criteria

$$WER \times [e^{\{0.8545[\ln(hardness)]-1.702\}}] \times (CF_c)$$
Where $CF_c = 0.96$

Using an average effluent hardness of 143 mg/L and a default WER value of 1.0 (**Attachment 6**). The following acute and chronic copper criteria were calculated.

| Acute Criteria | Chronic Criteria |
|---|---|
| 19 µg/L | 12 µg/L |

The 2012 WER study established a WER value of 5.984. The following acute and chronic copper criteria were derived by multiplication with the WER value of 5.984 (see **Attachment 9**).

| Acute Criteria | Chronic Criteria |
|---|---|
| 114 µg/L | 72 µg/L |

3) Bacteria Criteria:
The Virginia Water Quality Standards at 9VAC25-260-170A and the Maryland Water Quality Criteria Specific to Designated Uses (Code of Maryland Regulations 26.08.02.03-3.A) state that the following criteria shall apply to protect primary recreational uses in surface waters:

*E. coli* bacteria per 100 ml of water shall not exceed a monthly geometric mean of the following:

| | Geometric Mean* |
|---|---|
| Freshwater *E. coli* (N/100 ml) | 126 |

*For a minimum of four weekly samples [taken during any calendar month].

**Attachment 6** details other Virginia Water Quality Criteria applicable to the receiving stream.

d) Receiving Stream Special Standards
The State Water Control Board's Water Quality Standards, River Basin Section Tables (9VAC25-260-360, 370 and 380) designates the river basins, sections, classes, and special standards for surface waters of the Commonwealth of Virginia. The receiving stream, Difficult Run, UT, is located within Section 8 of the Potomac River Basin. This section has been designated with a special standard of PWS.

Special Standard PWS designates a public water supply intake. The Board's Water Quality Standards establish numerical standards for specific parameters calculated to protect human health from toxic effects through drinking water and fish consumption. See 9VAC25-260-140 B for applicable criteria.

e) Policy for Sewage Treatment in the Dulles Area Watershed
Chapter 9 VAC 401 of the State Water Control Law was established to regulate the discharge from sewage treatment plants in the Dulles Area Watershed, which is located upstream of several major public water supply intakes serving the Washington, D.C. metropolitan area. The outfall for the Madeira School WWTP will discharge to the affected area. Therefore, this Policy is applicable to this permit reissuance.

f) Threatened or Endangered Species
Records of the Virginia DGIF Fish and Wildlife Information System Database were searched to determine if there are threatened or endangered species in the vicinity of the discharge. The following federal and state endangered and threatened species were identified within a two-mile radius of the discharge: the Atlantic Sturgeon, the Brook Floater, the Wood Turtle, the Upland Sandpiper, the Migrant Loggerhead Shrike, the Loggerhead Shrike, Henslows Sparrow, and the Appalachian Grizzled Skipper. The limits proposed in this draft permit are protective of the Virginia Water Quality Standards and therefore, protect the state endangered and threatened species near the discharge.

The stream that the facility discharges to is within a reach identified as having an Anadromous Fish Use. It is staff's best professional judgment that the proposed limits are protective of this use.

**16. Antidegradation (9VAC25-260-30):**

All state surface waters are provided one of three levels of antidegradation protection. For Tier 1 or existing use protection, existing uses of the water body and the water quality to protect these uses must be maintained. Tier 2 water bodies have water quality that is better than the water quality standards. Significant lowering of the water quality of Tier 2 waters is not allowed without an evaluation of the economic and social impacts. Tier 3 water bodies are exceptional waters and are so designated by regulatory amendment. The antidegradation policy prohibits new or expanded discharges into exceptional waters.

The receiving stream has been classified as Tier 1 because the flow is minimal during critical drought conditions (e.g., 7Q10=0.0 MGD). Permit limits proposed have been established by determining wasteload allocations that will result in attaining and/or maintaining all water quality criteria that apply to the receiving stream, including narrative criteria. These wasteload allocations will provide for the protection and maintenance of all existing uses.

**17. Effluent Screening, Wasteload Allocation, and Effluent Limitation Development:**

To determine water quality-based effluent limitations for a discharge, the suitability of data must first be determined. Data is suitable for analysis if one or more representative data points are equal to or above the quantification level ("QL") and the data represent the exact pollutant being evaluated.

Next, the appropriate Water Quality Standards (WQS) are determined for the pollutants in the effluent. Then, the Wasteload Allocations (WLA) are calculated. Since the critical flows (1Q10, 7Q10, 30Q10) have been determined to be zero, the WLA's are equal to the WQS. The WLA values are then compared with available effluent data to determine the need for effluent limitations. Effluent limitations are needed if the 97th percentile of the daily effluent concentration values is greater than the acute wasteload allocation or if the 97th percentile of the four-day average

concentration values is greater than the acute wasteload allocation or if the 97th percentile of the four-day average effluent concentration values is greater than the chronic wasteload allocation. In the case of ammonia evaluations, limits are needed if the 97th percentile of the thirty-day average effluent concentration value is greater than the chronic WLA. Effluent limitations are based on the most limiting WLA, the required sampling frequency, and statistical characteristics of the effluent data.

a) Wasteload Allocations (WLAs):
WLAs are calculated for those parameters in the effluent with the reasonable potential to cause an exceedance of water quality criteria. The basic calculation for establishing a WLA is the steady state complete mix equation:

$$WLA = \frac{C_o[Q_e + (f)(Q_s)] - [(C_s)(f)(Q_s)]}{Q_e}$$

Where:
- WLA = Wasteload allocation
- $C_o$ = In-stream water quality criteria
- $Q_e$ = Design flow
- $Q_s$ = Critical receiving stream flow (1Q10 for acute aquatic life criteria; 7Q10 for chronic aquatic life criteria; 30Q10 for ammonia criteria; harmonic mean for carcinogen-human health criteria; and 30Q5 for non-carcinogen human health criteria)
- f = Decimal fraction of critical flow
- $C_s$ = Mean background concentration of parameter in the receiving stream.

The water segment receiving the discharge via Outfall 001has critical flows of 0.0 MGD. As such, there is no mixing zone and the WLA is equal to the $C_o$. Staff derived WLAs where parameters are reasonably expected to be present in an effluent (e.g., total residual chlorine where chlorine is used as a means of disinfection) and where effluent data indicate the pollutant is present in the discharge above quantifiable levels. With regard to the Outfall 001 discharge, ammonia as N is likely present since this is a wastewater treatment plant treating sewage and the DMR data indicate that copper is present in the discharge.

b) Effluent Limitations Toxic Pollutants -- Outfall 001
9VAC25-31-220.D. requires limits be imposed where a discharge has a reasonable potential to cause or contribute to an in-stream excursion of water quality criteria. Those parameters with WLAs that are near effluent concentrations are evaluated for limits.

The VPDES Permit Regulation at 9VAC25-31-230.D requires that monthly and weekly average limitations be imposed for continuous discharges from POTWs and monthly average and daily maximum limitations be imposed for all other continuous non-POTW discharges.

1) Ammonia as N/TKN:
Staff reevaluated pH and temperature data from January 2011 to December 2012 and has concluded that the pH data is significantly different than what was used previously to derive ammonia criteria (see Part 15. c) 1) of this fact sheet). As a result, staff used the new data to determine ammonia water quality criteria, wasteload allocations (WLAs) and ammonia limits (**Attachment 10**). DEQ guidance suggests using a sole data point of 9.0 mg/L to ensure the evaluation adequately addresses the potential for ammonia to be present in discharges containing domestic sewage. It was found that an average monthly limit of 1.8 mg/L and an average weekly limit of 2.6 mg/L for ammonia are needed. Since these newly calculated ammonia limits are less stringent that the current limits, the current average monthly limit of 0.90 mg/L and average weekly limit of 1.3 mg/L shall remain in the permit in accordance with the antibacksliding provisions of Section 402(o) of the Clean Water Act, 9VAC25-31-220.L., and 40 § CFR 122.44.

2) Metals:
Utilizing copper DMR data from March 2009 through September 2013 and WLAs established using the WER adjusted criteria derived from the Final Streamlined WER Report submitted to DEQ on October 29, 2012, it has been determined that a copper limit is not needed in this permit.

c) Effluent Limitations and Monitoring, Outfall 001 – Conventional and Non-Conventional Pollutants
No changes to the Dissolved Oxygen (D.O.), Biochemical Oxygen Demand-5 day ($BOD_5$), Total Suspended Solids (TSS), *E. coli*, and pH limitations are proposed.

D.O. and $BOD_5$, limitations at the 0.0395 MGD design flow tier are based on original modeling conducted on April 8, 1992. Additional modeling was conducted on February 26, 1998 for the 0.0495 MGD facility expansion. The limits for D.O. at the 0.0495 MGD design flow tier were derived using this model and are set to maintain the water quality criteria for D.O. in the receiving stream (see **Attachment 11**).

The TSS limitations are based on the 2008 Benthic TMDL for Difficult Run and best professional judgment. The sediment WLA for the Madeira School WWTP in the Benthic TMDL for Difficult Run is 2.25 tons/year (see **Attachment 12** for an excerpt of the TMDL). TSS limits are established to equal $BOD_5$ limits since the two pollutants are closely related in terms of treatment of domestic sewage. The $BOD_5$ and TSS loadings do not increase when the design flow is increased to 0.0495 MGD because this facility's discharge is governed by the Dulles Policy (9VAC25-401-401) that does not allow an increase in these loadings with flow expansion.

pH limitations are set at the Maryland Water Quality Criteria because the discharge is adjacent to the Maryland State line. Maryland pH criteria for pH are more stringent than the Virginia Water Quality Standards.

On July 14, 2004, *E. coli* limitations were removed from this permit because it was demonstrated that chlorine is an adequate surrogate for. *E. coli*. However, this facility has been assigned a wasteload allocation for *E. coli* in a TMDL for Difficult Run. Additionally, due to the removal of chlorine disinfection, adequate disinfection of treated wastewater must be confirmed through monitoring *E. coli* bacteria. *E. coli* limitations are in accordance with the Virginia Water Quality Standards 9VAC25-260-170 and the Maryland Water Quality Criteria.

Monitoring for influent Oil and Grease will be required annually due the presence of a commercial kitchen discharging to this small sewage treatment plant.

d) Effluent Annual Average Limitations and Monitoring, Outfall 001 – Nutrients
VPDES Regulation 9VAC25-31-220(D) requires effluent limitations that are protective of both the numerical and narrative water quality standards for state waters, including the Chesapeake Bay.

As discussed in Section 15, significant portions of the Chesapeake Bay and its tributaries are listed as impaired with nutrient enrichment cited as one of the primary causes. Virginia has committed to protecting and restoring the Bay and its tributaries. Only concentration limits are now found in the individual VPDES permit when the facility installs nutrient removal technology. The basis for the concentration limits is 9VAC25-40 - *Regulation for Nutrient Enriched Waters and Dischargers within the Chesapeake Bay Watershed* which requires new discharges greater than 0.001 MGD or expanding discharges to treat for TN and TP to either Biological Nutrient Removal levels (TN = 8 mg/L; TP = 1.0 mg/L) or State of the Art levels (TN = 3.0 mg/L and TP = 0.3 mg/L).

This facility has also obtained coverage under VAC25-820 *General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia.* This regulation specifies and controls the nitrogen and phosphorus loadings from facilities and specifies facilities that must register under the general permit. Nutrient loadings for those facilities registered under the general permit as well as compliance

schedules and other permit requirements, shall be authorized, monitored, limited, and otherwise regulated under the general permit and not this individual permit. This facility has coverage under this General Permit; the permit number is VAN010124.

Monitoring for Nitrates + Nitrites, TKN, TN, and TP are included in this permit. The monitoring is needed to protect the Water Quality Standards of the Chesapeake Bay and shall apply if the facility expands to the 0.049 MGD flow tier. Monitoring frequencies are set at the frequencies set forth in 9VAC25-820. Annual average effluent limitations for TN and TP, determined by 9VAC25-40-70.2 and DEQ Guidance Memo No. 07-2008, Permitting Considerations for Facilities in the Chesapeake Bay Watershed, are included in this individual permit. At the 0.0495 MGD Design Flow Tier, monthly and year to date calculations are also a part of this individual permit. The annual averages are based on the offset plan submitted as part of the Registration Statement for 9VAC25-820, 9VAC25-40, and GM07-2008.

e) Effluent Limitations and Monitoring Summary.
The effluent limitations are presented in the following table. Limits were established for $BOD_5$, TSS, Ammonia as N, pH, D.O., *E. coli*, TN, and TP.

The mass loading (kg/d) for monthly and weekly averages were calculated by multiplying the concentration values (mg/L), with the flow values (in MGD) and a conversion factor of 3.785. In accordance with the Dulles Policy, 9VAC25-400, the $BOD_5$ and TSS mass limits shall be retained at the 0.0395 MGD loading.

The VPDES Permit Regulation at 9VAC25-31-30 and 40 CFR Part 133 require that the facility achieve at least 85% removal for BOD/CBOD and TSS (or 65% for equivalent to secondary). The limits in this permit are water-quality-based effluent limits and result in greater than 85% removal.

**18. Antibacksliding:**

All limits in this permit with the exception of total recoverable copper are at least as stringent as those previously established. Backsliding in this permit reissuance only applies to total recoverable copper.

The total recoverable copper limits were removed as part of this reissuance based on the results of the Water Effects Ratio Study dated October 29, 2012. The backsliding proposed conforms to the antibacksliding provisions of Section 402(o) of the Clean Water Act, 9 VAC 25-31-220.L., and 40 § CFR 122.44. The revisions to the water quality based copper limits are allowed since the revisions comply with the water quality standards, 402(o)(3), and they are consistent with antidegradation (303(d)(4)(B)).

**19. a Effluent Limitations/Monitoring Requirements:**

Design flow is 0.0395 MGD.

Effective Dates: During the period beginning with the permit's effective date and lasting until the CTO is issued for the 0.0495 MGD facility or the permit expiration date, whichever comes first.

| PARAMETER | BASIS FOR LIMITS | DISCHARGE LIMITATIONS | | | | MONITORING REQUIREMENTS | |
|---|---|---|---|---|---|---|---|
| | | Monthly Average | Weekly Average | Minimum | Maximum | Frequency | Sample Type |
| Flow (MGD) | NA | NL | NA | NA | NL | Continuous | TIRE |
| pH | 1 | NA | NA | 6.5 S.U. | 8.5 S.U. | 1/D | Grab |
| $BOD_5$ | 1, 2, 3, 4 | 30 mg/L 4.5 kg/day | 45 mg/L 6.7 kg/day | NA | NA | 1/W | 4H-C |
| Total Suspended Solids (TSS) [a] | 2, 5, 6 | 30 mg/L 4.5 kg/day | 45 mg/L 6.7 kg/day | NA | NA | 1/W | 4H-C |
| Dissolved Oxygen (DO) | 1, 2, 3 | NA | NA | 6.0 mg/L | NA | 1/D | Grab |
| Ammonia, as N (mg/L) | 1, 2 | 0.90 | 1.3 | NA | NA | 1/W | 4H-C |
| *E. coli* (Geometric Mean) | 1, 2, 4 | 126 n/100ml | NA | NA | NA | 1/W [b] | Grab |
| Influent Oil and Grease | 5 | NA | NA | NA | NL | 1/Y [c] | Grab |

The basis for the limitations codes are:

1. MD Water Quality Criteria
2. Dulles Policy (9VAC25-400)
3. VA Water Quality Standards
4. Stream Model (**Attachment 11**)
5. Approved TMDL (see Section 17.b)
6. Best Professional Judgment

MGD = Million gallons per day.
NA = Not applicable.
NL = No limit; monitor and report.
TIRE = Totalizing, indicating and recording equipment.
S.U. = Standard units.

1/D = Once every day.
1/W = Once every week.
1/Y = Once every year.

4H-C = A flow proportional composite sample collected manually or automatically, and discretely or continuously, for the entire discharge of the monitored 4-hour period. Where discrete sampling is employed, the permittee shall collect a minimum of four (4) aliquots for compositing. Discrete sampling may be flow proportioned either by varying the time interval between each aliquot or the volume of each aliquot. Time composite samples consisting of a minimum four (4) grab samples obtained at hourly or smaller intervals may be collected where the permittee demonstrates that the discharge flow rate (gallons per minute) does not vary by 10% or more during the monitored discharge.

Grab = An individual sample collected over a period of time not to exceed 15-minutes.

a. TSS shall be expressed as two significant figures.

b. Samples shall be collected between 10:00 a.m. and 4:00 p.m.

c. Sampling shall be conducted during Jan-May or Sep-Dec of each year.

**19. b Effluent Limitations/Monitoring Requirements:**

Design flow is 0.0495 MGD.

Effective Dates: During the period beginning with the issuance of the CTO for the 0.0495 MGD facility and lasting until the permit expiration date.

| PARAMETER | BASIS FOR LIMITS | DISCHARGE LIMITATIONS | | | | MONITORING REQUIREMENTS | |
|---|---|---|---|---|---|---|---|
| | | Monthly Average | Weekly Average | Minimum | Maximum | Frequency | Sample Type |
| Flow (MGD) | NA | NL | NA | NA | NL | Continuous | TIRE |
| pH | 1 | NA | NA | 6.5 S.U. | 8.5 S.U. | 1/D | Grab |
| $BOD_5$ | 1, 2, 3, 4 | 30 mg/L 4.5 kg/day | 45 mg/L 6.7 kg/day | NA | NA | 1/W | 8H-C |
| Total Suspended Solids (TSS) [a] | 2, 5, 6 | 30 mg/L 4.5 kg/day | 45 mg/L 6.7 kg/day | NA | NA | 1/W | 8H-C |
| Dissolved Oxygen (DO) | 1, 3, 4 | NA | NA | 6.0 mg/L | NA | 1/D | Grab |
| Ammonia, as N (mg/L) | 1, 3, 4 | 0.90 | 1.3 | NA | NA | 1/W | 8H-C |
| *E. coli* (Geometric Mean) | 1, 3 | 126 n/100ml | NA | NA | NA | 2D/W [b] | Grab |
| Influent Oil and Grease | 6 | NA | NA | NA | NL | 1/Y [c] | Grab |
| Total Kjeldahl Nitrogen (TKN) | 3, 7 | NL mg/L | NA | NA | NA | 1/M | 8H-C |
| Nitrate+Nitrite, as N | 3, 7 | NL mg/L | NA | NA | NA | 1/M | 8H-C |
| Total Nitrogen [d] | 3, 7 | NL mg/L | NA | NA | NA | 1/M | Calculated |
| Total Nitrogen – Year to Date [e] | 3, 7 | NL mg/L | NA | NA | NA | 1/M | Calculated |
| Total Nitrogen - Calendar Year [e] | 3, 7 | 8.0 mg/L | NA | NA | NA | 1/Y | Calculated |
| Total Phosphorus | 3, 7 | NL mg/L | NA | NA | NA | 1/M | 4H-C |
| Total Phosphorus – Year to Date [e] | 3, 7 | NL mg/L | NA | NA | NA | 1/M | Calculated |
| Total Phosphorus - Calendar Year [e] | 3, 7 | 1.0 mg/L | NA | NA | NA | 1/Y | Calculated |

The basis for the limitations codes are:

1. MD Water Quality Criteria
2. Dulles Policy (9VAC25-400)
3. VA Water Quality Standards
4. Stream Model (**Attachment 11**)
5. Approved TMDL (see Section 17.b)
6. Best Professional Judgment
7. 9VAC25-40 (Nutrient Regulation)

MGD = Million gallons per day.
NA = Not applicable.
NL = No limit; monitor and report.
TIRE = Totalizing, indicating and recording equipment.
S.U. = Standard units.

1/D = Once every day.
1/W = Once every week.
2D/W = Two days a week.
1/M = Once every month.
1/Y = Once every year.

8H-C = A flow proportional composite sample collected manually or automatically, and discretely or continuously, for the entire discharge of the monitored 4-hour period. Where discrete sampling is employed, the permittee shall collect a minimum of four (4) aliquots for compositing. Discrete sampling may be flow proportioned either by varying the time interval between each aliquot or the volume of each aliquot. Time composite samples consisting of a minimum four (4) grab samples obtained at hourly or smaller intervals may be collected where the permittee demonstrates that the discharge flow rate (gallons per minute) does not vary by 10% or more during the monitored discharge.

Grab = An individual sample collected over a period of time not to exceed 15-minutes.

a. TSS shall be expressed as two significant figures.

b. Samples shall be collected between 10:00 a.m. and 4:00 p.m.

c. Sampling shall be conducted during Jan-May or Sep-Dec of each year.

d. Total Nitrogen = Sum of TKN plus Nitrate+Nitrite

e. See Section 20.a. for more information on the Nutrient Calculations.

**20. Other Permit Requirements:**

a) Part I.B. of the permit contains additional chlorine monitoring requirements, quantification levels and compliance reporting instructions.
9VAC25-31-190.L.4.c. requires an arithmetic mean for measurement averaging and 9VAC25-31-220.D requires limits be imposed where a discharge has a reasonable potential to cause or contribute to an in-stream excursion of water quality criteria. Specific analytical methodologies for toxics are listed in this permit section as well as quantification levels (QLs) necessary to demonstrate compliance with applicable permit limitations or for use in future evaluations to determine if the pollutant has reasonable potential to cause or contribute to a violation. Required averaging methodologies are also specified.

The calculations for the Nitrogen and Phosphorus parameters shall be in accordance with the calculations set forth in 9VAC25-820 *General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia*. §62.1-44.19:13 of the Code of Virginia defines how annual nutrient loads are to be calculated; this is carried forward in 9VAC25-820-70. As annual concentrations (as opposed to loads) are limited in the individual permit, these reporting calculations are intended to reconcile the reporting calculations between the permit programs, as the permittee is collecting a single set of samples for the purpose of ascertaining compliance with two permits.

**21. Other Special Conditions:**

a) 95% Capacity Reopener. The VPDES Permit Regulation at 9VAC25-31-200.B.4 requires all POTWs and PVOTWs develop and submit a plan of action to DEQ when the monthly average influent flow to their sewage treatment plant reaches 95% or more of the design capacity authorized in the permit for each month of any three consecutive month period. The facility is a PVOTW.

b) Indirect Dischargers. Required by VPDES Permit Regulation 9VAC25-31-200 B.1 and B.2 for POTWs and PVOTWs that receive waste from someone other than the owner of the treatment works.

c) O&M Manual Requirement. Required by the Code of Virginia at §62.1-44.19; the Sewage Collection and Treatment Regulations at 9VAC25-790; and the VPDES Permit Regulation at 9VAC25-31-190.E. The permittee shall maintain a current Operations and Maintenance (O&M) Manual. The permittee shall operate the treatment w works in accordance with the O&M Manual and shall make the O&M Manual available to Department personnel for review upon request. Any changes in the practices and procedures followed by the permittee shall be documented in the O&M Manual within 90 days of the effective date of the changes. Non-compliance with the O&M Manual shall be deemed a violation of the permit.

d) CTC, CTO Requirement. The Code of Virginia at § 62.1-44.19 and the Sewage Collection and Treatment Regulation at 9VAC25-790 require that all treatment works treating wastewater obtain a Certificate to Construct prior to commencing construction and to obtain a Certificate to Operate prior to commencing operation of the treatment works.

e) Licensed Operator Requirement. The Code of Virginia at §54.1-2300 et seq., the VPDES Permit Regulation at 9VAC25-31-200 C, and the Rules and Regulations for Waterworks and Wastewater Works Operators at 18VAC160-20-10 et seq. require licensure of operators. This facility requires a Class III operator.

f) Reliability Class. The Sewage Collection and Treatment Regulations at 9VAC25-790 require sewage treatment works to achieve a certain level of reliability in order to protect water quality and public health consequences in the event of component or system failure. Reliability means a measure of the ability of the treatment works to perform its designated function without failure or interruption of service. The facility is required to meet a Reliability Class of I due to the presence of public water supply intake downstream of the discharge.

g) Sludge Reopener. The VPDES Permit Regulation at 9VAC25-31-220.C. requires all permits issued to treatment works treating domestic sewage (including sludge-only facilities) include a reopener clause allowing incorporation of any applicable standard for sewage sludge use or disposal promulgated under Section 405(d) of the CWA.

h) Sludge Use and Disposal. The VPDES Permit Regulation at 9VAC25-31-100.P; 220.B.2. and 420 through 720 and 40 CFR Part 503 require all treatment works treating domestic sewage to submit information on their sludge use and disposal practices and to meet specified standards for sludge use and disposal. The facility includes a treatment works treating domestic sewage.

i) Nutrient Offsets. The Virginia General Assembly, in their 2005 session, enacted a new Article 4.02 (Chesapeake Bay Watershed Nutrient Credit Exchange Program) to the Code of Virginia to address nutrient loads to the Bay. Section 62.1-44.19:15 sets forth the requirements for new and expanded dischargers, which are captured by the requirements of the law, including the requirement that non-point load reductions acquired for the purpose of offsetting nutrient discharges be enforced through the individual VPDES permit.

j) E3/E4. 9VAC25-40-70 B authorizes DEQ to approve an alternate compliance method to the technology-based effluent concentration limitations as required by subsection A of this section. Such alternate compliance method shall be incorporated into the permit of an Exemplary Environmental Enterprise (E3) facility or an Extraordinary Environmental Enterprise (E4) facility to allow the suspension of applicable technology-based effluent concentration limitations during the period the E3 or E4 facility has a fully implemented environmental management system that includes operation of installed nutrient removal technologies at the treatment efficiency levels for which they were designed.

k) Nutrient Reopener. 9VAC25-40-70 A authorizes DEQ to include technology-based annual concentration limits in the permits of facilities that have installed nutrient control equipment, whether by new construction, expansion or upgrade. 9VAC25-31-390 A authorizes DEQ to modify VPDES permits to promulgate amended water quality standards.

l) TMDL Reopener. This special condition is to allow the permit to be reopened if necessary to bring it into compliance with any applicable TMDL that may be developed and approved for the receiving stream.

**22.** Permit Section Part II. Part II of the permit contains standard conditions that appear in all VPDES Permits. In general, these standard conditions address the responsibilities of the permittee, reporting requirements, testing procedures and records retention.

**23. Changes to the Permit from the Previously Issued Permit:**

a) Special Conditions: None

b) Monitoring and Effluent Limitations:
1) The copper limits have been removed based on the results of a WER study reviewed and approved by DEQ in January 2013.
2) Monitoring for *E. coli* has been increased from a frequency of twice per month to once per week at the 0.395 MGD design flow tier and two days per week at the 0.0495 MGD design flow tier.

3) Chlorine monitoring has been removed from the permit due to removal of chlorine disinfection and the installation of UV disinfection.
4) Monitoring for influent oil and grease has been changed from twice per year to once per year.
5) Monitoring and/or analysis for Nitrate+Nitrite, as N, TKN, Total Nitrogen, Total Nitrogen – Year to Date, Total Phosphorus, and Total Phosphorus Year to Date has changed from twice per month to once per month at the 0.0495 MGD Design Flow Tier in accordance with current DEQ Guidance.

c) Other:
1) Part II of the permit has been updated to include VELAP language.

**23. Variances/Alternate Limits or Conditions:** None

**24. Public Notice Information:**

First Public Notice Date: January 8, 2014 Second Public Notice Date: January 15, 2014

Public Notice Information is required by 9VAC25-31-280 B. All pertinent information is on file and may be inspected, and copied by contacting the: DEQ Northern Regional Office, 13901 Crown Court, Woodbridge, VA 22193, Telephone No. (703) 583-3837, anna.westernik@deq.virginia.gov. See **Attachment 13** for a copy of the public notice document.

Persons may comment in writing or by email to the DEQ on the proposed permit action, and may request a public hearing, during the comment period. Comments shall include the name, address, and telephone number of the writer and of all persons represented by the commenter/requester, and shall contain a complete, concise statement of the factual basis for comments. Only those comments received within this period will be considered. The DEQ may decide to hold a public hearing, including another comment period, if public response is significant and there are substantial, disputed issues relevant to the permit. Requests for public hearings shall state 1) the reason why a hearing is requested; 2) a brief, informal statement regarding the nature and extent of the interest of the requester or of those represented by the requester, including how and to what extent such interest would be directly and adversely affected by the permit; and 3) specific references, where possible, to terms and conditions of the permit with suggested revisions. Following the comment period, the Board will make a determination regarding the proposed permit action. This determination will become effective, unless the DEQ grants a public hearing. Due notice of any public hearing will be given. The public may request an electronic copy of the draft permit and fact sheet or review the draft permit and application at the DEQ Northern Regional Office by appointment.

**25. Additional Comments:**

a) Previous Board Actions:
The following is a brief history of DEQ State Water Control Board Actions:

On December 14, 2011, the Madeira School entered into an amendment of the March 2006 consent order with DEQ; this order is still in effect. This order requires that the school complete a WER Study in response to the copper limitation violations and incorporate the results of the WER Study into the permit. Additionally, the order states that the treatment plant shall be operated in a workman-like manner (**Attachment 8**). Permit copper limits were suspended after the order was signed.

The Madeira School WWTP entered into a consent order with DEQ on March 17, 2006. This order required that the school complete a sewer line connection to Fairfax County or construct a new sewage treatment plant. In accordance with this consent order, the Madeira School submitted plans and specifications for the construction of a new wastewater treatment plant to DEQ-NRO Office of Wastewater Engineering staff on February 1, 2008. These plans and specifications were approved by DEQ on May 30, 2008. The Certificate to Operate for the new sewage treatment plant was issued on June 9, 2010.

Violations of chlorine and ammonia (due to operator error) were found in September 2002. Ammonia violations were found in December 2002. Ammonia violations were found in September and November 2003. Violations of ammonia and BOD were found in December 2003. BOD violations were found in January and March 2004. Ammonia violations were present in April and May 2004. The case was referred to enforcement in July 2004.

This facility was referred to enforcement in March 2002 due to violations of the limits for BOD, TSS, and ammonia found in their VPDES permit. Repairs were made to the diffusers in the sludge digester, the drain line, and the recirculation pump. The system was monitored for two months and returned to compliance. The case was de-referred in April 2002.

This facility was referred to DEQ enforcement in March 1997. The wastewater treatment plant was upgraded in September 1997 to resolve problems with BOD, ammonia, sludge, and TSS. The upgrade consisted of installing a new trickling filter, a new pumping system, and a reserve break point chlorination system. The case was de-referred in October 1998.

b) Staff Comments:
Ernie Aschenbach of the Virginia Department of Game and Inland Fisheries (VDGIF) reviewed the 2013 permit application for Madeira School on July 31, 2013 and stated the following: "According to our records, Difficult Run is a designated Threatened and Endangered (T&E) species water for the state Threatened (ST) wood turtle. In general, we recommend and support ultraviolet (UV) disinfection rather than chlorination disinfection. We support the continued dechlorination of effluent. Provided the applicant adheres to the effluent characteristics identified in the permit application, we do not anticipate the issuance of this permit to result in adverse impact to T&E species waters or their associated species."

Alli Baird of the Virginia Department of Conservation and Recreation reviewed the 2013 permit application for Madeira School on July 18, 2013. In the review, Ms. Baird stated that due to the legal status of the Wood Turtle, DCR recommends coordination with VDGIF to ensure compliance with the Virginia Endangered Species Act. Ms. Baird copied Amy Ewing of VDGIF on the correspondence, which can be found in the permit reissuance file.

Mr. Brett Hillman of the U.S. Fish and Wildlife Service review the 2013 permit application on October 21, 2013 and stated the following: "Based on the project description and location, it appears that no impacts to federally listed species or designated critical habitat will occur, and we have no further comment."

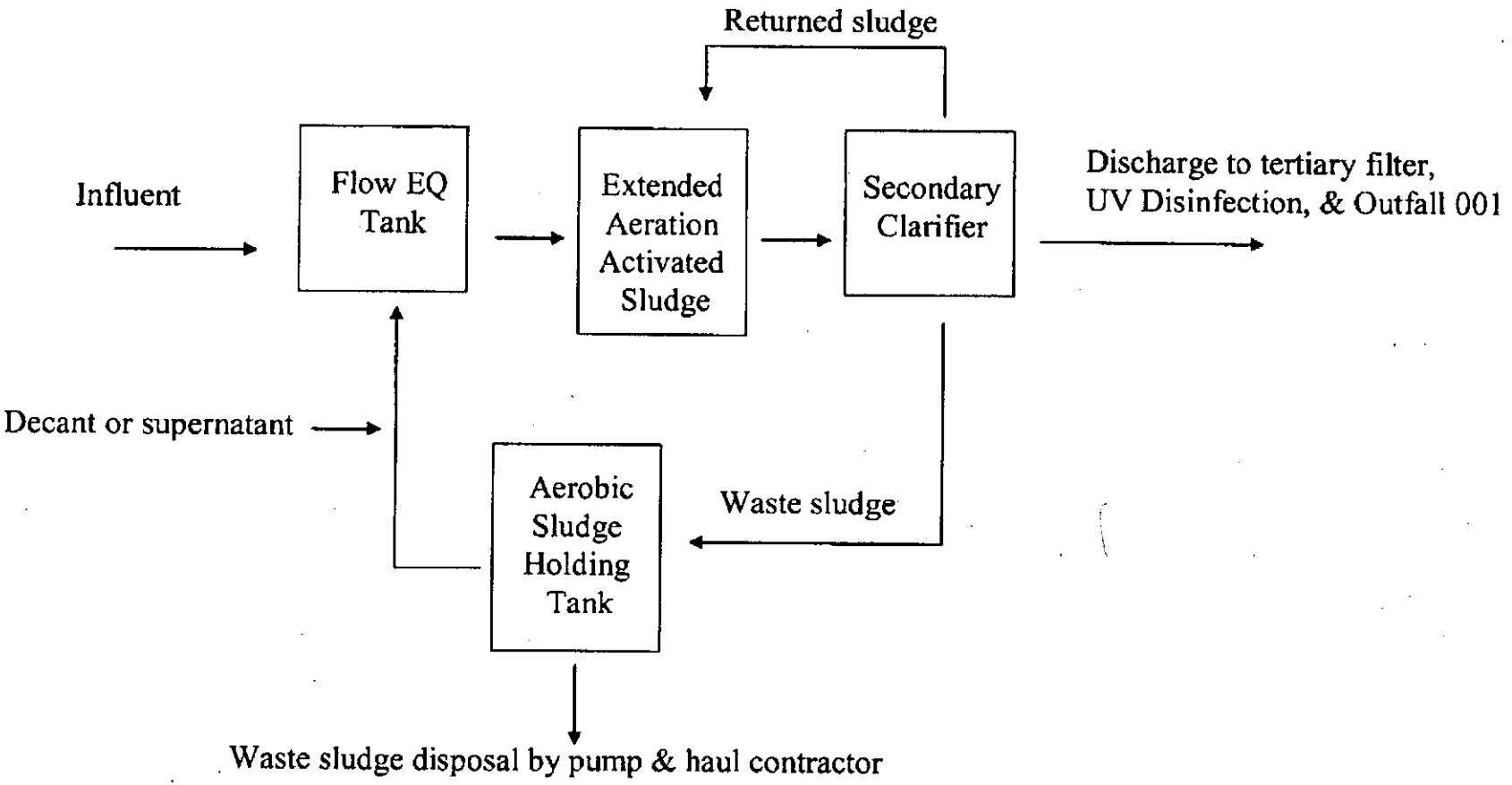
c) Public Comment: No comments were received during the public notice period.

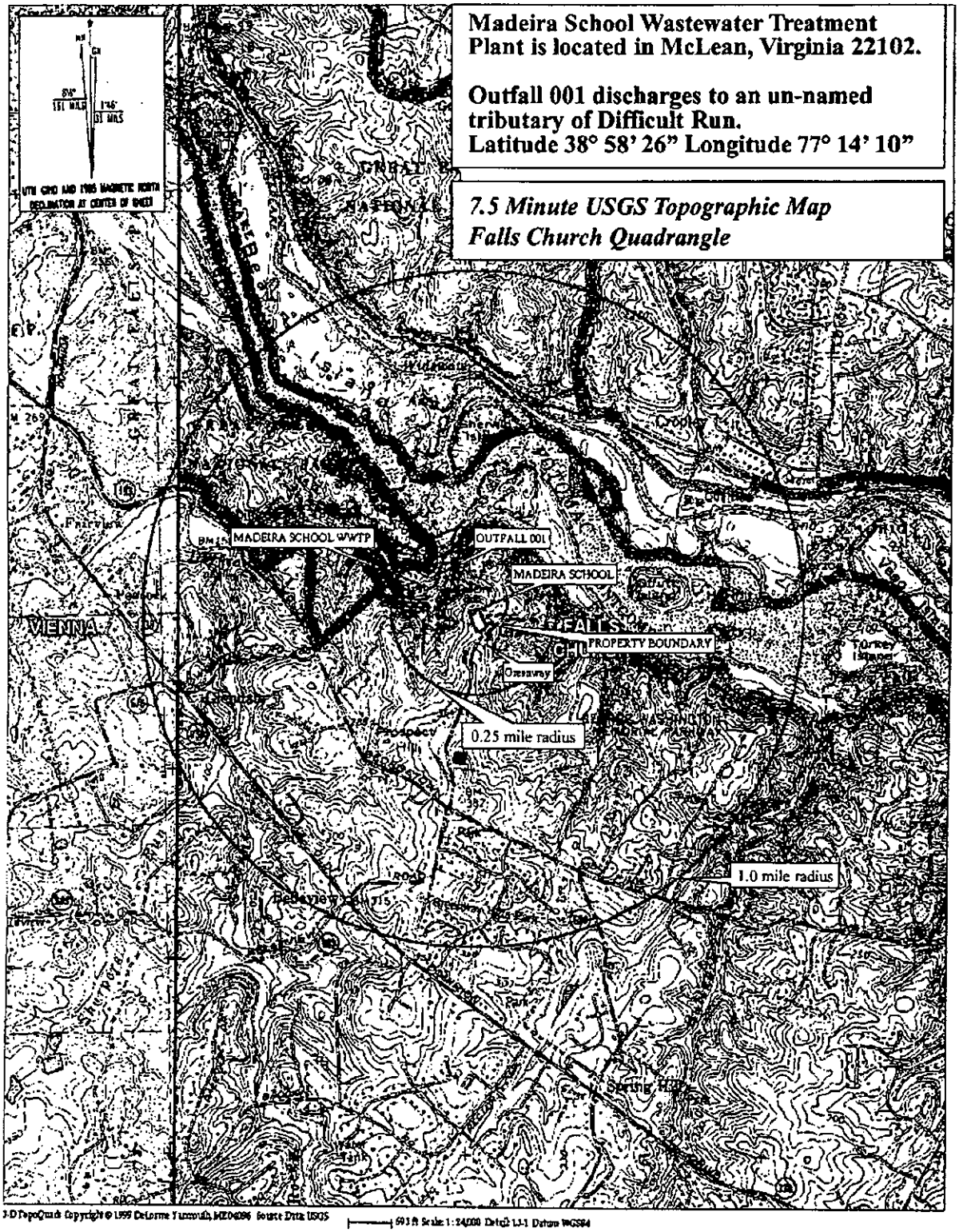
## Attachments

| | |
|---|---|
| Attachment 1 - | Facility Schematic/Diagram |
| Attachment 2 | Falls Church Topographic Map – #204D |
| Attachment 3 - | Site Visit Memorandum Dated July 18, 2013 |
| Attachment 4 - | Planning Statement for Madeira School dated February 3, 2014 |
| Attachment 5 | Derivation of 90$^{th}$ Percentile pH and Temperature Values |
| Attachment 6 - | VA Freshwater Water Quality Criteria and Wasteload Allocations |
| Attachment 7 - | Summary of Copper Monitoring Data from March 2009 to September 2013 |
| Attachment 8 - | Appendix A, Schedule A of the Consent Special Order dated December 14, 2011 |
| Attachment 9- | Final Streamlined WER Report and the DEQ Review Memorandum Dated January 24, 2013 |
| Attachment 10 - | Derivation of Effluent Limits |
| Attachment 11 - | Stream Model |
| Attachment 12 - | Excerpt of 2008 Benthic TMDL for Difficult Run |
| Attachment 13 | Public Notice |

# Sewage Sludge Processes
# The Madeira School

**Attachment 1**




Madeira School Wastewater Treatment Plant is located in McLean, Virginia 22102.
Outfall 001 discharges to an un-named tributary of Difficult Run.
Latitude 38° 58' 26" Longitude 77° 14' 10"
7.5 Minute USGS Topographic Map
Falls Church Quadrangle
MADEIRA SCHOOL WWTP
OUTFALL 001
MADEIRA SCHOOL
PROPERTY BOUNDARY
0.25 mile radius
1.0 mile radius
VIENNA
FALLS CHURCH
Parkway
Prospect
Bellevue
Spring Hill
Cooley
Turner Island

VIRGINIA DEPARTMENT OF
ENVIRONMENTAL QUALITY

# MEMORANDUM

Northern Regional Office

**TO:** File

**FROM:** Anna Westernik, Water Permit Writer

**DATE:** July 18, 2013

**SUBJECT:** July 1, 2013 Site Inspection of the Madeira School STP (VA0024121)

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I met with ESS and Madeira School staff at the Madeira School STP on July 1, 2013 as part of the permit reissuance. David Campbell from ESS and Bob Vogel with the school provided a brief tour of the facility. The facility is located below the school grounds near the Potomac River.

Sewage influent flows via gravity from the collection system to the headworks of the sewage treatment plant. Preliminary treatment at the headworks consists of solids removal through an automatic barscreen with a manual barscreen backup. From the barscreen, flow enters the equalization basin where soda ash is fed.

There are two pumps in the equalization basin that split the sewage flow through a junction box to 5 aeration treatment trains, with 10 basins total. The RAS is fed into the first aeration treatment train. After secondary treatment, the sewage is sent to two clarifiers and filtration. The filters are backwashed daily. Filtrate is sent to the head of the plant.

Flow is metered after filtration and sent to two UV banks for disinfection. Only one is in operation. The current intensity is 3.5 $mW/cm^2$. Grab samples are collected after UV disinfection and composite samples are taken at the outfall. The current flow on this date is 26,000 gpd. Only summer camp is in session.

The unnamed tributary to Difficult Run at the discharge location consists of approximately a 50:50 pool and riffle ratio. The water was clear. Crayfish and caddisflies were observed in the pool. Difficult Run itself was very muddy. However, there have been significant recent rain events.

**Attachment 3**

| | |
|---|---|
| To: | Anna Westernik |
| From: | Jennifer Carlson |
| Date: | February 3, 2014 |
| Subject: | Permit Planning Statement for the Madeira School WWTP |
| Permit Number: | VA0024121 |

**Information for Outfall 001:**

| | |
|---|---|
| Discharge Type: | Municipal |
| Discharge Flow: | 0.0495 MGD |
| Receiving Stream: | UT of Difficult Run |
| Latitude / Longitude: | 38° 58' 18.6"; -77° 14' 7.4" |
| Rivermile: | 0.2 |
| Streamcode: | 1aXGF |
| Waterbody: | VAN-A11R |
| Water Quality Standards: | Class III, Section 8. Special Standards: PWS |
| Drainage Area: | 0.0455 $mi^2$ |

1. Please provide water quality monitoring information for the receiving stream segment. If there is not monitoring information for the receiving stream segment, please provide information on the nearest downstream monitoring station, including how far downstream the monitoring station is from the outfall.

   This facility discharges into an unnamed tributary to Difficult Run (1aXGF). There is no DEQ water quality monitoring station on this unnamed tributary. The nearest DEQ monitoring station is 1aDIF000.86, which is located on Difficult Run at the Route 193 bridge crossing. (Note: This station is located upstream from where the Unnamed Tributary (XGF) enters Difficult Run. However, 1aDIF000.86 is used to assess the water quality on Difficult Run at the confluence with the unnamed tributary, 1aXGF). Station 1aDIF000.86 is located approximately 0.88 rivermiles from Outfall 001. The following is the water quality summary for this portion of Difficult Run, as taken from the 2012 Integrated Assessment:

   *Class III, Section 8, special stds. PWS.*

   *Monitoring stations located on this segment of Difficult Run:*
   - *DEQ ambient, biological, and sediment monitoring station 1aDIF000.86, at Route 193*
   - *DEQ biological monitoring station 1aDIF000.80, downstream of Route 193*
   - *USGS gage station 016246000*

   *The fish consumption use is categorized as impaired due to a Virginia Department of Health, Division of Health Hazards Control, PCB fish consumption advisory and for heptachlor epoxide based on fish tissue monitoring. The impairment for the fish consumption use based on heptachlor epoxide in fish tissue was first listed in 2006 and will continue to stand as there has been no additional data collected for this parameter. Additionally, there was an exceedance of the water quality criterion based tissue value (TV) of 300 ppb for mercury in American eel (2004), and an exceedance of the water quality criterion based tissue value (TV) of 110 ppb for total chlordane in American eel (2004), both of which are noted by an observed effect for the fish consumption use.*

**Attachment 4**

*Biological monitoring finds a benthic macroinvertebrate impairment, resulting in an impaired classification for the aquatic life use. Additionally, the data collected by the citizen monitoring group indicate that a water quality issue may exist; however, the methodology and/or data quality has not been approved for such a determination. Citizen monitoring finds a medium probability of adverse conditions for biota. A benthic TMDL has been completed and approved for Difficult Run.*

*The recreation, public water supply and wildlife uses are considered fully supporting.*

2. Does this facility discharge to a stream segment on the 303(d) list?

No.

3. Are there any downstream 303(d) listed impairments that are relevant to this discharge? If yes, please fill out Table B.

**Table B. Information on Downstream 303(d) Impairments and TMDLs**

| Waterbody Name | Impaired Use | Cause | Distance From Outfall | TMDL completed | WLA | Basis for WLA | TMDL Schedule |
|---|---|---|---|---|---|---|---|
| ***Impairment Information in the 2012 Integrated Report*** | | | | | | | |
| Difficult Run | Aquatic Life | Benthic Macroinvertebrates: Sediment | 0.2 miles | Yes | 2.3 tons/year of sediment | Max Permitted Design Flow (0.0495 MGD) and TSS Concentration (30mg/L) | Completed in 2008 |
| | Fish Consumption | PCBs in Fish Tissue | 0.2 miles | No | N/A | N/A | 2018 |
| | Fish Consumption | Heptachlor Epoxide | 0.2 miles | No | N/A | N/A | 2018 |

This facility was also assigned a WLA of 8.62E+10 cfu/year of *E. coli* in the Difficult Run Bacteria TMDL that was approved by EPA on 11/7/2008. The segment of Difficult Run located 0.2 miles downstream of Outfall 001 was previously listed with a recreation use impairment. In the 2012 Integrated Report, the recreation use was impairment was delisted and the segment was classified as supporting the recreation use. The WLA established for this facility in the TMDL remains in effect.

4. Is there monitoring or other conditions that Planning/Assessment needs in the permit?

There is a PCB impairment in Difficult Run. However, DEQ Staff has concluded that low-level PCB monitoring is not warranted for this facility, as it is a small wastewater treatment facility and is unlikely to discharge any PCBs.

There is a completed downstream TMDL for the aquatic life use impairment for the Chesapeake Bay. However, the Bay TMDL and the WLAs contained within the TMDL are not addressed in this planning statement.

5. Fact Sheet Requirements – Please provide information regarding any drinking water intakes located within a 5 mile radius of the discharge point.

   There are several drinking water intakes within a 5 mile radius of this facility; however, it should be noted that all of these intakes are located on the Potomac River, upstream from where Difficult Run flows into the Potomac River.

   Great Falls Intake – Under DCWASA
   Rockville Intake
   WSC Intake

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 – December 2012**

| | | |
|---|---|---|
| 1/1/2011 | 7.10 | 9.6 |
| 1/2/2011 | 7.57 | 5.5 |
| 1/3/2011 | 7.41 | 5.3 |
| 1/4/2011 | 7.61 | 5.2 |
| 1/5/2011 | 7.43 | 5.9 |
| 1/6/2011 | 7.41 | 6.0 |
| 1/7/2011 | 7.42 | 6.6 |
| 1/8/2011 | 7.54 | 6.6 |
| 1/9/2011 | 7.58 | 5.9 |
| 1/10/2011 | 7.60 | 4.2 |
| 1/11/2011 | 7.74 | 5.1 |
| 1/12/2011 | 7.51 | 5.0 |
| 1/13/2011 | 7.80 | 5.4 |
| 1/14/2011 | 7.82 | 4.9 |
| 1/15/2011 | 7.69 | 5.6 |
| 1/16/2011 | 7.51 | 6.3 |
| 1/17/2011 | 7.87 | 6.2 |
| 1/18/2011 | 7.37 | 6.3 |
| 1/19/2011 | 7.62 | 6.7 |
| 1/20/2011 | 7.50 | 6.9 |
| 1/21/2011 | 7.81 | 6.8 |
| 1/22/2011 | 7.63 | 6.8 |
| 1/23/2011 | 7.82 | 5.3 |
| 1/24/2011 | 7.62 | 5.0 |
| 1/25/2011 | 7.53 | 5.4 |
| 1/26/2011 | 7.60 | 5.8 |
| 1/27/2011 | 7.50 | 6.2 |
| 1/28/2011 | 7.84 | 6.0 |
| 1/29/2011 | 7.30 | 5.7 |
| 1/30/2011 | 7.56 | 5.4 |
| 1/31/2011 | 7.57 | 6.0 |
| 2/1/2011 | 7.62 | 5.3 |
| 2/2/2011 | 7.78 | 6.3 |
| 2/3/2011 | 7.61 | 6.3 |
| 2/4/2011 | 7.71 | 5.2 |
| 2/5/2011 | 7.36 | 6.1 |
| 2/6/2011 | 7.30 | 6.0 |
| 2/7/2011 | 7.66 | 6.3 |
| 2/8/2011 | 7.60 | 6.5 |
| 2/9/2011 | 7.70 | 5.9 |
| 2/10/2011 | 7.50 | 5.8 |
| 2/11/2011 | 7.65 | 4.9 |
| 2/12/2011 | 7.88 | 4.9 |



**Attachment 5**

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 2/13/2011 | 7.31 | 5.3 |
| 2/14/2011 | 7.71 | 6.3 |
| 2/15/2011 | 7.60 | 6.6 |
| 2/16/2011 | 7.66 | 6.4 |
| 2/17/2011 | 7.68 | 7.1 |
| 2/18/2011 | 7.69 | 8.4 |
| 2/19/2011 | 8.11 | 8.2 |
| 2/20/2011 | 8.03 | 10.5 |
| 2/21/2011 | 7.91 | 7.9 |
| 2/22/2011 | 7.71 | 6.9 |
| 2/23/2011 | 7.62 | 6.9 |
| 2/24/2011 | 7.61 | 6.7 |
| 2/25/2011 | 7.67 | 7.5 |
| 2/26/2011 | 7.26 | 7.6 |
| 2/27/2011 | 7.20 | 8.1 |
| 2/28/2011 | 7.84 | 8.6 |
| 3/1/2011 | 7.58 | 8.3 |
| 3/2/2011 | 7.46 | 8.4 |
| 3/3/2011 | 7.60 | 9.1 |
| 3/4/2011 | 7.56 | 8.8 |
| 3/5/2011 | 7.50 | 10.6 |
| 3/6/2011 | 7.56 | 10.6 |
| 3/7/2011 | 7.51 | 9.5 |
| 3/8/2011 | 7.53 | 10.7 |
| 3/9/2011 | 7.50 | 10.4 |
| 3/10/2011 | 7.65 | 11.1 |
| 3/11/2011 | 7.48 | 11.6 |
| 3/12/2011 | 7.45 | 9.1 |
| 3/13/2011 | 7.97 | 9.5 |
| 3/14/2011 | 7.56 | 12.1 |
| 3/15/2011 | 7.60 | 11.0 |
| 3/16/2011 | 7.58 | 11.2 |
| 3/17/2011 | 7.66 | 11.2 |
| 3/18/2011 | 7.57 | 13.3 |
| 3/19/2011 | 8.11 | 11.4 |
| 3/20/2011 | 7.68 | 10.9 |
| 3/21/2011 | 7.67 | 11.6 |
| 3/22/2011 | 7.58 | 11.9 |
| 3/23/2011 | 7.49 | 12.0 |
| 3/24/2011 | 7.65 | 11.5 |
| 3/25/2011 | 7.56 | 10.4 |
| 3/26/2011 | 7.49 | 10.2 |
| 3/27/2011 | 7.70 | 9.7 |
| 3/28/2011 | 7.68 | 9.5 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 3/29/2011 | 7.52 | 9.4 |
| 3/30/2011 | 7.35 | 10.2 |
| 3/31/2011 | 7.53 | 10.4 |
| 4/1/2011 | 7.58 | 10.7 |
| 4/2/2011 | 7.65 | 11.3 |
| 4/3/2011 | 7.51 | 11.4 |
| 4/4/2011 | 7.59 | 11.5 |
| 4/5/2011 | 7.44 | 12.9 |
| 4/6/2011 | 7.61 | 12.7 |
| 4/7/2011 | 7.67 | 13.3 |
| 4/8/2011 | 7.65 | 13.4 |
| 4/9/2011 | 7.33 | 13.1 |
| 4/10/2011 | 8.08 | 20.1 |
| 4/11/2011 | 7.64 | 14.3 |
| 4/12/2011 | 7.53 | 15.2 |
| 4/13/2011 | 7.56 | 15.6 |
| 4/14/2011 | 7.62 | 15.1 |
| 4/15/2011 | 7.71 | 15.1 |
| 4/16/2011 | 7.56 | 15.1 |
| 4/17/2011 | 7.47 | 15.0 |
| 4/18/2011 | 7.64 | 15.4 |
| 4/19/2011 | 7.85 | 16.8 |
| 4/20/2011 | 7.54 | 16.0 |
| 4/21/2011 | 7.55 | 16.5 |
| 4/22/2011 | 7.90 | 16.9 |
| 4/23/2011 | 7.41 | 18.0 |
| 4/24/2011 | 7.56 | 18.1 |
| 4/25/2011 | 7.77 | 19.0 |
| 4/26/2011 | 7.55 | 19.3 |
| 4/27/2011 | 7.73 | 19.7 |
| 4/28/2011 | 7.63 | 20.4 |
| 4/29/2011 | 7.94 | 19.8 |
| 4/30/2011 | 8.00 | 18.6 |
| 5/1/2011 | 7.62 | 18.6 |
| 5/2/2011 | 7.81 | 17.6 |
| 5/3/2011 | 7.56 | 19.2 |
| 5/4/2011 | 7.66 | 19.5 |
| 5/5/2011 | 7.66 | 17.8 |
| 5/6/2011 | 7.90 | 17.4 |
| 5/7/2011 | 7.95 | 23.1 |
| 5/8/2011 | 7.89 | 20.8 |
| 5/9/2011 | 7.67 | 18.3 |
| 5/10/2011 | 7.58 | 18.4 |
| 5/11/2011 | 7.62 | 20.1 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 5/12/2011 | 7.59 | 18.3 |
| 5/13/2011 | 7.28 | 18.7 |
| 5/14/2011 | 7.94 | 18.7 |
| 5/15/2011 | 7.83 | 19.1 |
| 5/16/2011 | 7.97 | 19.5 |
| 5/17/2011 | 7.63 | 19.5 |
| 5/18/2011 | 7.71 | 19.9 |
| 5/19/2011 | 7.77 | 19.6 |
| 5/20/2011 | 7.72 | 19.3 |
| 5/21/2011 | 7.68 | 19.9 |
| 5/22/2011 | 7.75 | 19.8 |
| 5/23/2011 | 7.62 | 20.4 |
| 5/24/2011 | 7.49 | 21.0 |
| 5/25/2011 | 7.57 | 21.5 |
| 5/26/2011 | 7.56 | 21.8 |
| 5/27/2011 | 7.55 | 23.1 |
| 5/28/2011 | 7.55 | 22.7 |
| 5/29/2011 | 7.59 | 22.9 |
| 5/30/2011 | 7.61 | 22.8 |
| 5/31/2011 | 7.67 | 23.4 |
| 6/1/2011 | 7.66 | 24.1 |
| 6/2/2011 | 7.66 | 23.7 |
| 6/3/2011 | 7.78 | 22.7 |
| 6/4/2011 | 7.58 | 22.1 |
| 6/5/2011 | 7.80 | 22.5 |
| 6/6/2011 | 7.90 | 22.0 |
| 6/7/2011 | 7.92 | 22.3 |
| 6/8/2011 | 7.84 | 22.4 |
| 6/9/2011 | 7.70 | 23.2 |
| 6/10/2011 | 7.86 | 23.5 |
| 6/11/2011 | 7.92 | 23.8 |
| 6/12/2011 | 7.86 | 23.8 |
| 6/13/2011 | 7.61 | 23.3 |
| 6/14/2011 | 7.68 | 22.4 |
| 6/15/2011 | 7.73 | 21.8 |
| 6/16/2011 | 7.69 | 21.7 |
| 6/17/2011 | 7.62 | 21.8 |
| 6/18/2011 | 7.45 | 22.4 |
| 6/19/2011 | 7.50 | 22.7 |
| 6/20/2011 | 7.62 | 22.4 |
| 6/21/2011 | 7.61 | 22.5 |
| 6/22/2011 | 7.59 | 22.9 |
| 6/23/2011 | 7.60 | 23.4 |
| 6/24/2011 | 7.85 | 23.5 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 6/25/2011 | 7.62 | 23.5 |
| 6/26/2011 | 7.67 | 22.9 |
| 6/27/2011 | 7.68 | 22.9 |
| 6/28/2011 | 7.55 | 23.1 |
| 6/29/2011 | 7.81 | 23.4 |
| 6/30/2011 | 7.62 | 23.1 |
| 7/1/2011 | 7.65 | 23.0 |
| 7/2/2011 | 6.98 | 22.9 |
| 7/3/2011 | 7.50 | 24.4 |
| 7/4/2011 | 7.63 | 23.6 |
| 7/5/2011 | 7.65 | 23.7 |
| 7/6/2011 | 7.75 | 24.2 |
| 7/7/2011 | 7.67 | 24.3 |
| 7/8/2011 | 7.60 | 24.5 |
| 7/9/2011 | 7.82 | 24.5 |
| 7/10/2011 | 7.87 | 24.6 |
| 7/11/2011 | 7.65 | 24.7 |
| 7/12/2011 | 7.77 | 24.9 |
| 7/13/2011 | 7.75 | 25.2 |
| 7/14/2011 | 7.69 | 24.6 |
| 7/15/2011 | 7.80 | 24.1 |
| 7/16/2011 | 7.88 | 23.6 |
| 7/17/2011 | 7.49 | 23.7 |
| 7/18/2011 | 7.75 | 24.1 |
| 7/19/2011 | 7.88 | 24.6 |
| 7/20/2011 | 7.65 | 25.1 |
| 7/21/2011 | 7.64 | 25.6 |
| 7/22/2011 | 7.67 | 26.2 |
| 7/23/2011 | 6.94 | 26.8 |
| 7/24/2011 | 6.77 | 27.2 |
| 7/25/2011 | 7.60 | 26.5 |
| 7/26/2011 | 7.57 | 26.2 |
| 7/27/2011 | 7.58 | 26.0 |
| 7/28/2011 | 7.65 | 25.7 |
| 7/29/2011 | 7.63 | 26.0 |
| 7/30/2011 | 7.84 | 26.3 |
| 7/31/2011 | 7.90 | 26.0 |
| 8/1/2011 | 7.69 | 25.8 |
| 8/2/2011 | 7.71 | 25.3 |
| 8/3/2011 | 7.70 | 25.8 |
| 8/4/2011 | 7.89 | 25.6 |
| 8/5/2011 | 7.68 | 25.3 |
| 8/6/2011 | 7.86 | 25.5 |
| 8/7/2011 | 7.79 | 25.8 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 8/8/2011 | 7.65 | 25.7 |
| 8/9/2011 | 7.78 | 25.6 |
| 8/10/2011 | 7.82 | 25.3 |
| 8/11/2011 | 7.67 | 24.7 |
| 8/12/2011 | 7.69 | 24.2 |
| 8/13/2011 | 7.60 | 24.1 |
| 8/14/2011 | 7.92 | 24.4 |
| 8/15/2011 | 7.67 | 24.1 |
| 8/16/2011 | 7.86 | 23.8 |
| 8/17/2011 | 7.98 | 23.6 |
| 8/18/2011 | 7.66 | 23.8 |
| 8/19/2011 | 7.71 | 23.6 |
| 8/20/2011 | 7.88 | 23.7 |
| 8/21/2011 | 7.60 | 24.1 |
| 8/22/2011 | 7.69 | 23.8 |
| 8/23/2011 | 7.85 | 23.2 |
| 8/24/2011 | 7.94 | 22.6 |
| 8/25/2011 | 7.80 | 23.0 |
| 8/26/2011 | 7.69 | 23.9 |
| 8/27/2011 | 7.66 | 23.7 |
| 8/28/2011 | 7.93 | 23.2 |
| 8/29/2011 | 7.84 | 22.8 |
| 8/30/2011 | 7.75 | 22.2 |
| 8/31/2011 | 7.84 | 22.0 |
| 9/1/2011 | 8.01 | 22.3 |
| 9/2/2011 | 7.81 | 22.6 |
| 9/3/2011 | 7.45 | 22.9 |
| 9/4/2011 | 7.61 | 23.4 |
| 9/5/2011 | 7.64 | 23.9 |
| 9/6/2011 | 7.68 | 23.7 |
| 9/7/2011 | 7.64 | 23.3 |
| 9/8/2011 | 7.57 | 24.4 |
| 9/9/2011 | 7.63 | 23.6 |
| 9/10/2011 | 7.62 | 23.7 |
| 9/11/2011 | 7.67 | 23.8 |
| 9/12/2011 | 7.67 | 23.6 |
| 9/13/2011 | 7.68 | 23.6 |
| 9/14/2011 | 7.63 | 23.8 |
| 9/15/2011 | 7.61 | 24.0 |
| 9/16/2011 | 7.66 | 22.6 |
| 9/17/2011 | 7.53 | 21.8 |
| 9/18/2011 | 7.22 | 21.4 |
| 9/19/2011 | 7.60 | 21.2 |
| 9/20/2011 | 7.61 | 21.3 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 – December 2012**

| | | |
|---|---|---|
| 9/21/2011 | 7.62 | 21.9 |
| 9/22/2011 | 7.67 | 22.8 |
| 9/23/2011 | 7.65 | 23.2 |
| 9/24/2011 | 7.67 | 23.4 |
| 9/25/2011 | 7.92 | 23.4 |
| 9/26/2011 | 7.66 | 23.6 |
| 9/27/2011 | 7.62 | 23.8 |
| 9/28/2011 | 7.62 | 23.8 |
| 9/29/2011 | 7.69 | 23.7 |
| 9/30/2011 | 7.73 | 23.0 |
| 10/1/2011 | 7.85 | 22.1 |
| 10/2/2011 | 7.66 | 20.7 |
| 10/3/2011 | 7.64 | 19.4 |
| 10/4/2011 | 7.64 | 19.2 |
| 10/5/2011 | 7.68 | 19.2 |
| 10/6/2011 | 7.67 | 19.0 |
| 10/7/2011 | 7.72 | 18.9 |
| 10/8/2011 | 7.87 | 18.9 |
| 10/9/2011 | 7.71 | 18.9 |
| 10/10/2011 | 7.72 | 19.2 |
| 10/11/2011 | 7.82 | 19.9 |
| 10/12/2011 | 7.81 | 20.4 |
| 10/13/2011 | 7.70 | 20.6 |
| 10/14/2011 | 7.58 | 21.1 |
| 10/15/2011 | 7.51 | 20.5 |
| 10/16/2011 | 7.98 | 19.1 |
| 10/17/2011 | 7.77 | 19.4 |
| 10/18/2011 | 7.49 | 19.1 |
| 10/19/2011 | 7.52 | 19.7 |
| 10/20/2011 | 7.58 | 19.7 |
| 10/21/2011 | 7.58 | 18.6 |
| 10/22/2011 | 7.55 | 18.5 |
| 10/23/2011 | 7.59 | 17.9 |
| 10/24/2011 | 7.49 | 17.6 |
| 10/25/2011 | 7.58 | 17.5 |
| 10/26/2011 | 7.62 | 17.6 |
| 10/27/2011 | 7.57 | 17.9 |
| 10/28/2011 | 7.87 | 17.2 |
| 10/29/2011 | 7.36 | 17.4 |
| 10/30/2011 | 7.56 | 20.4 |
| 10/31/2011 | 7.80 | 14.6 |
| 11/1/2011 | 7.60 | 14.7 |
| 11/2/2011 | 7.46 | 14.7 |
| 11/3/2011 | 7.62 | 15.0 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 11/4/2011 | 7.55 | 15.3 |
| 11/5/2011 | 7.74 | 14.9 |
| 11/6/2011 | 7.72 | 13.9 |
| 11/7/2011 | 7.66 | 14.5 |
| 11/8/2011 | 7.73 | 14.4 |
| 11/9/2011 | 7.72 | 14.5 |
| 11/10/2011 | 7.60 | 15.4 |
| 11/11/2011 | 7.73 | 14.7 |
| 11/12/2011 | 7.73 | 13.7 |
| 11/13/2011 | 7.86 | 14.2 |
| 11/14/2011 | 7.68 | 14.5 |
| 11/15/2011 | 7.54 | 15.6 |
| 11/16/2011 | 7.60 | 16.5 |
| 11/17/2011 | 7.57 | 16.0 |
| 11/18/2011 | 7.77 | 14.9 |
| 11/19/2011 | 7.46 | 16.4 |
| 11/20/2011 | 7.55 | 14.3 |
| 11/21/2011 | 7.45 | 14.9 |
| 11/22/2011 | 7.68 | 14.8 |
| 11/23/2011 | 7.99 | 15.0 |
| 11/24/2011 | 7.91 | 19.0 |
| 11/25/2011 | 7.53 | 19.0 |
| 11/26/2011 | 7.56 | 19.0 |
| 11/27/2011 | 7.54 | 19.2 |
| 11/28/2011 | 7.57 | 13.5 |
| 11/29/2011 | 7.47 | 14.2 |
| 11/30/2011 | 7.64 | 14.0 |
| 12/1/2011 | 7.67 | 13.1 |
| 12/2/2011 | 7.42 | 12.8 |
| 12/3/2011 | 7.67 | 12.5 |
| 12/4/2011 | 7.46 | 12.3 |
| 12/5/2011 | 7.63 | 12.8 |
| 12/6/2011 | 7.38 | 13.7 |
| 12/7/2011 | 7.37 | 14.9 |
| 12/8/2011 | 7.35 | 14.3 |
| 12/9/2011 | 7.48 | 13.3 |
| 12/10/2011 | 7.32 | 13.4 |
| 12/11/2011 | 7.96 | 11.7 |
| 12/12/2011 | 7.47 | 11.2 |
| 12/13/2011 | 7.39 | 10.8 |
| 12/14/2011 | 7.44 | 11.0 |
| 12/15/2011 | 7.54 | 11.6 |
| 12/16/2011 | 7.51 | 12.4 |
| 12/17/2011 | 7.49 | 11.9 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 12/18/2011 | 7.49 | 11.0 |
| 12/19/2011 | 7.73 | 10.5 |
| 12/20/2011 | 7.54 | 10.9 |
| 12/21/2011 | 7.57 | 11.3 |
| 12/22/2011 | 7.56 | 11.7 |
| 12/23/2011 | 7.55 | 11.7 |
| 12/24/2011 | 7.53 | 11.7 |
| 12/25/2011 | 7.63 | 12.8 |
| 12/26/2011 | 7.37 | 9.4 |
| 12/27/2011 | 7.76 | 9.8 |
| 12/28/2011 | 7.66 | 7.6 |
| 12/29/2011 | 7.69 | 8.6 |
| 12/30/2011 | 7.71 | 8.5 |
| 12/31/2011 | 7.90 | 11.7 |
| 1/1/2012 | 7.95 | 9.0 |
| 1/2/2012 | 7.62 | 8.8 |
| 1/3/2012 | 7.70 | 7.8 |
| 1/4/2012 | 7.50 | 6.7 |
| 1/5/2012 | 7.35 | 7.5 |
| 1/6/2012 | 7.41 | 8.1 |
| 1/7/2012 | 7.55 | 9.2 |
| 1/8/2012 | 7.90 | 11.2 |
| 1/9/2012 | 7.52 | 9.8 |
| 1/10/2012 | 7.55 | 9.6 |
| 1/11/2012 | 7.42 | 9.6 |
| 1/12/2012 | 7.53 | 10.8 |
| 1/13/2012 | 7.59 | 10.9 |
| 1/14/2012 | 7.56 | 10.3 |
| 1/15/2012 | 7.58 | 9.4 |
| 1/16/2012 | 7.54 | 8.4 |
| 1/17/2012 | 7.43 | 9.3 |
| 1/18/2012 | 7.63 | 9.7 |
| 1/19/2012 | 7.77 | 9.0 |
| 1/20/2012 | 7.61 | 9.2 |
| 1/21/2012 | 7.63 | 9.7 |
| 1/22/2012 | 7.63 | 9.0 |
| 1/23/2012 | 7.82 | 8.4 |
| 1/24/2012 | 7.73 | 9.3 |
| 1/25/2012 | 7.47 | 10.0 |
| 1/26/2012 | 7.65 | 10.4 |
| 1/27/2012 | 7.62 | 12.0 |
| 1/28/2012 | 7.70 | 11.7 |
| 1/29/2012 | 7.72 | 11.2 |
| 1/30/2012 | 7.73 | 10.5 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 1/31/2012 | 7.82 | 10.6 |
| 2/1/2012 | 7.79 | 11.5 |
| 2/2/2012 | 7.75 | 12.4 |
| 2/3/2012 | 7.81 | 11.8 |
| 2/4/2012 | 8.02 | 10.6 |
| 2/5/2012 | 7.82 | 10.9 |
| 2/6/2012 | 7.94 | 10.3 |
| 2/7/2012 | 8.05 | 10.9 |
| 2/8/2012 | 7.80 | 10.7 |
| 2/9/2012 | 7.53 | 10.3 |
| 2/10/2012 | 7.73 | 10.6 |
| 2/11/2012 | 7.64 | 11.0 |
| 2/12/2012 | 7.56 | 9.8 |
| 2/13/2012 | 7.73 | 9.1 |
| 2/14/2012 | 7.72 | 9.2 |
| 2/15/2012 | 7.76 | 9.7 |
| 2/16/2012 | 7.92 | 10.0 |
| 2/17/2012 | 8.03 | 10.2 |
| 2/18/2012 | 7.76 | 19.0 |
| 2/19/2012 | 8.03 | 10.2 |
| 2/20/2012 | 8.23 | 9.1 |
| 2/21/2012 | 7.86 | 9.5 |
| 2/22/2012 | 7.89 | 9.9 |
| 2/23/2012 | 7.92 | 10.8 |
| 2/24/2012 | 7.78 | 12.1 |
| 2/25/2012 | 8.11 | 11.0 |
| 2/26/2012 | 8.06 | 10.7 |
| 2/27/2012 | 7.81 | 10.8 |
| 2/28/2012 | 7.71 | 11.2 |
| 2/29/2012 | 7.81 | 11.3 |
| 3/1/2012 | 7.88 | 12.3 |
| 3/2/2012 | 7.81 | 12.1 |
| 3/3/2012 | 6.81 | 13.5 |
| 3/4/2012 | 7.65 | 12.7 |
| 3/5/2012 | 7.73 | 11.5 |
| 3/6/2012 | 7.73 | 10.9 |
| 3/7/2012 | 7.78 | 11.2 |
| 3/8/2012 | 7.79 | 12.3 |
| 3/9/2012 | 7.75 | 12.9 |
| 3/10/2012 | 7.63 | 12.9 |
| 3/11/2012 | 7.82 | 12.1 |
| 3/12/2012 | 7.71 | 12.6 |
| 3/13/2012 | 7.74 | 13.7 |
| 3/14/2012 | 7.75 | 14.8 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 3/15/2012 | 7.47 | 15.5 |
| 3/16/2012 | 7.74 | 16.8 |
| 3/17/2012 | 7.47 | 15.5 |
| 3/18/2012 | 7.47 | 16.9 |
| 3/19/2012 | 7.78 | 16.4 |
| 3/20/2012 | 7.86 | 17.0 |
| 3/21/2012 | 7.87 | 16.9 |
| 3/22/2012 | 7.86 | 16.6 |
| 3/23/2012 | 7.80 | 17.8 |
| 3/24/2012 | 7.96 | 18.1 |
| 3/25/2012 | 8.18 | 16.6 |
| 3/26/2012 | 8.09 | 16.8 |
| 3/27/2012 | 8.22 | 15.2 |
| 3/28/2012 | 7.98 | 14.7 |
| 3/29/2012 | 7.86 | 15.2 |
| 3/30/2012 | 7.91 | 14.5 |
| 3/31/2012 | 7.74 | 14.1 |
| 4/1/2012 | 7.90 | 14.1 |
| 4/2/2012 | 7.75 | 14.3 |
| 4/3/2012 | 7.66 | 14.1 |
| 4/4/2012 | 7.68 | 14.4 |
| 4/5/2012 | 7.78 | 14.7 |
| 4/6/2012 | 7.85 | 14.3 |
| 4/7/2012 | 7.74 | 14.7 |
| 4/8/2012 | 7.77 | 14.7 |
| 4/9/2012 | 7.88 | 14.5 |
| 4/10/2012 | 7.78 | 14.7 |
| 4/11/2012 | 7.85 | 14.3 |
| 4/12/2012 | 7.86 | 14.2 |
| 4/13/2012 | 7.83 | 14.1 |
| 4/14/2012 | 7.86 | 14.2 |
| 4/15/2012 | 7.83 | 14.1 |
| 4/16/2012 | 7.77 | 16.7 |
| 4/17/2012 | 7.78 | 17.5 |
| 4/18/2012 | 7.88 | 17.6 |
| 4/19/2012 | 8.06 | 17.3 |
| 4/20/2012 | 8.02 | 17.5 |
| 4/21/2012 | 7.94 | 18.0 |
| 4/22/2012 | 8.09 | 19.1 |
| 4/23/2012 | 7.82 | 16.9 |
| 4/24/2012 | 7.81 | 15.9 |
| 4/25/2012 | 7.83 | 15.5 |
| 4/26/2012 | 7.74 | 16.0 |
| 4/27/2012 | 7.71 | 16.5 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 4/28/2012 | 7.70 | 18.4 |
| 4/29/2012 | 7.58 | 19.5 |
| 4/30/2012 | 7.79 | 16.1 |
| 5/1/2012 | 7.71 | 16.6 |
| 5/2/2012 | 7.58 | 17.8 |
| 5/3/2012 | 7.69 | 18.2 |
| 5/4/2012 | 7.87 | 19.0 |
| 5/5/2012 | 7.75 | 19.3 |
| 5/6/2012 | 7.85 | 19.6 |
| 5/7/2012 | 7.66 | 19.6 |
| 5/8/2012 | 7.93 | 19.3 |
| 5/9/2012 | 7.75 | 19.8 |
| 5/10/2012 | 7.88 | 19.4 |
| 5/11/2012 | 7.94 | 18.6 |
| 5/12/2012 | 7.94 | 18.5 |
| 5/13/2012 | 7.95 | 19.4 |
| 5/14/2012 | 8.03 | 19.4 |
| 5/15/2012 | 7.92 | 19.8 |
| 5/16/2012 | 7.94 | 20.3 |
| 5/17/2012 | 8.08 | 20.3 |
| 5/18/2012 | 8.02 | 19.8 |
| 5/19/2012 | 7.93 | 19.7 |
| 5/20/2012 | 8.15 | 20.0 |
| 5/21/2012 | 7.89 | 20.5 |
| 5/22/2012 | 7.98 | 20.8 |
| 5/23/2012 | 8.00 | 21.0 |
| 5/24/2012 | 8.04 | 21.3 |
| 5/25/2012 | 8.04 | 21.8 |
| 5/26/2012 | 8.16 | 22.3 |
| 5/27/2012 | 8.11 | 22.6 |
| 5/28/2012 | 8.07 | 22.6 |
| 5/29/2012 | 8.05 | 22.9 |
| 5/30/2012 | 8.14 | 23.1 |
| 5/31/2012 | 8.09 | 22.9 |
| 6/1/2012 | 8.17 | 22.9 |
| 6/2/2012 | 8.29 | 22.6 |
| 6/3/2012 | 7.54 | 22.1 |
| 6/4/2012 | 8.13 | 21.5 |
| 6/5/2012 | 8.09 | 21.0 |
| 6/6/2012 | 8.12 | 20.3 |
| 6/7/2012 | 8.09 | 20.3 |
| 6/8/2012 | 8.12 | 20.2 |
| 6/9/2012 | 8.12 | 20.3 |
| 6/10/2012 | 8.12 | 20.2 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 6/11/2012 | 8.01 | 21.4 |
| 6/12/2012 | 7.98 | 22.4 |
| 6/13/2012 | 7.99 | 21.8 |
| 6/14/2012 | 7.94 | 21.6 |
| 6/15/2012 | 7.91 | 21.6 |
| 6/16/2012 | 7.78 | 21.4 |
| 6/17/2012 | 7.84 | 21.2 |
| 6/18/2012 | 7.86 | 21.2 |
| 6/19/2012 | 7.84 | 21.3 |
| 6/20/2012 | 7.78 | 22.3 |
| 6/21/2012 | 7.72 | 23.0 |
| 6/22/2012 | 7.78 | 23.7 |
| 6/23/2012 | 6.91 | 24.7 |
| 6/24/2012 | 7.83 | 23.9 |
| 6/25/2012 | 7.81 | 23.9 |
| 6/26/2012 | 7.85 | 22.8 |
| 6/27/2012 | 7.96 | 22.4 |
| 6/28/2012 | 7.79 | 22.6 |
| 6/29/2012 | 7.99 | 23.3 |
| 6/30/2012 | 7.07 | 25.6 |
| 7/1/2012 | 7.62 | 24.7 |
| 7/2/2012 | 7.94 | 24.7 |
| 7/3/2012 | 8.02 | 24.6 |
| 7/4/2012 | 7.90 | 24.7 |
| 7/5/2012 | 7.94 | 24.9 |
| 7/6/2012 | 8.08 | 25.4 |
| 7/7/2012 | 8.04 | 25.1 |
| 7/8/2012 | 7.96 | 26.1 |
| 7/9/2012 | 8.06 | 25.9 |
| 7/10/2012 | 8.09 | 25.6 |
| 7/11/2012 | 8.12 | 25.3 |
| 7/12/2012 | 7.91 | 24.9 |
| 7/13/2012 | 7.88 | 24.6 |
| 7/14/2012 | 7.68 | 24.7 |
| 7/15/2012 | 7.61 | 25.1 |
| 7/16/2012 | 7.61 | 25.9 |
| 7/17/2012 | 7.83 | 25.4 |
| 7/18/2012 | 7.88 | 25.7 |
| 7/19/2012 | 8.05 | 25.9 |
| 7/20/2012 | 8.00 | 25.7 |
| 7/21/2012 | 7.92 | 25.2 |
| 7/22/2012 | 7.77 | 24.5 |
| 7/23/2012 | 7.82 | 24.6 |
| 7/24/2012 | 8.00 | 24.7 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 7/25/2012 | 7.98 | 24.4 |
| 7/26/2012 | 7.92 | 24.4 |
| 7/27/2012 | 7.73 | 24.9 |
| 7/28/2012 | 7.61 | 20.8 |
| 7/29/2012 | 7.76 | 20.7 |
| 7/30/2012 | 7.82 | 25.0 |
| 7/31/2012 | 8.02 | 25.2 |
| 8/1/2012 | 7.97 | 25.1 |
| 8/2/2012 | 7.87 | 25.1 |
| 8/3/2012 | 7.92 | 25.6 |
| 8/4/2012 | 7.64 | 25.9 |
| 8/5/2012 | 7.70 | 26.1 |
| 8/6/2012 | 7.85 | 26.2 |
| 8/7/2012 | 7.82 | 26.1 |
| 8/8/2012 | 7.93 | 26.0 |
| 8/9/2012 | 7.82 | 25.7 |
| 8/10/2012 | 7.94 | 25.4 |
| 8/11/2012 | 7.93 | 25.3 |
| 8/12/2012 | 7.93 | 25.7 |
| 8/13/2012 | 7.92 | 24.5 |
| 8/14/2012 | 7.89 | 24.8 |
| 8/15/2012 | 8.09 | 24.9 |
| 8/16/2012 | 7.97 | 24.4 |
| 8/17/2012 | 7.98 | 24.3 |
| 8/18/2012 | 7.93 | 24.3 |
| 8/19/2012 | 7.83 | 23.8 |
| 8/20/2012 | 7.80 | 23.4 |
| 8/21/2012 | 7.78 | 22.9 |
| 8/22/2012 | 7.68 | 23.0 |
| 8/23/2012 | 7.71 | 22.9 |
| 8/24/2012 | 7.74 | 23.3 |
| 8/25/2012 | 6.69 | 20.7 |
| 8/26/2012 | 7.92 | 20.7 |
| 8/27/2012 | 7.81 | 23.4 |
| 8/28/2012 | 7.81 | 23.7 |
| 8/29/2012 | 7.83 | 23.4 |
| 8/30/2012 | 7.87 | 23.3 |
| 8/31/2012 | 7.98 | 23.6 |
| 9/1/2012 | 7.70 | 24.2 |
| 9/2/2012 | 7.79 | 24.6 |
| 9/3/2012 | 7.91 | 24.8 |
| 9/4/2012 | 7.98 | 24.9 |
| 9/5/2012 | 7.89 | 25.2 |
| 9/6/2012 | 7.82 | 25.4 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 9/7/2012 | 7.94 | 25.4 |
| 9/8/2012 | 7.77 | 25.7 |
| 9/9/2012 | 7.75 | 25.4 |
| 9/10/2012 | 8.01 | 23.8 |
| 9/11/2012 | 7.87 | 22.9 |
| 9/12/2012 | 7.89 | 22.5 |
| 9/13/2012 | 7.91 | 22.4 |
| 9/14/2012 | 8.05 | 22.2 |
| 9/15/2012 | 7.84 | 21.8 |
| 9/16/2012 | 7.84 | 21.8 |
| 9/17/2012 | 8.10 | 21.5 |
| 9/18/2012 | 7.93 | 22.4 |
| 9/19/2012 | 8.01 | 21.9 |
| 9/20/2012 | 7.95 | 21.1 |
| 9/21/2012 | 7.84 | 21.3 |
| 9/22/2012 | 7.76 | 21.9 |
| 9/23/2012 | 7.62 | 21.6 |
| 9/24/2012 | 7.97 | 20.8 |
| 9/25/2012 | 7.99 | 20.1 |
| 9/26/2012 | 8.07 | 20.8 |
| 9/27/2012 | 7.91 | 21.5 |
| 9/28/2012 | 8.05 | 22.0 |
| 9/29/2012 | 7.89 | 19.6 |
| 9/30/2012 | 7.76 | 21.0 |
| 10/1/2012 | 7.98 | 20.5 |
| 10/2/2012 | 7.92 | 21.0 |
| 10/3/2012 | 8.00 | 21.5 |
| 10/4/2012 | 7.90 | 22.4 |
| 10/5/2012 | 7.98 | 22.1 |
| 10/6/2012 | 7.98 | 22.2 |
| 10/7/2012 | 7.95 | 22.2 |
| 10/8/2012 | 7.97 | 19.7 |
| 10/9/2012 | 7.79 | 19.1 |
| 10/10/2012 | 7.79 | 19.1 |
| 10/11/2012 | 7.81 | 18.5 |
| 10/12/2012 | 7.86 | 18.3 |
| 10/13/2012 | 7.91 | 17.9 |
| 10/14/2012 | 7.83 | 17.8 |
| 10/15/2012 | 7.98 | 18.6 |
| 10/16/2012 | 8.03 | 18.7 |
| 10/17/2012 | 7.85 | 18.2 |
| 10/18/2012 | 7.10 | 18.3 |
| 10/19/2012 | 7.88 | 19.0 |
| 10/20/2012 | 7.95 | 19.0 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 10/21/2012 | 7.94 | 18.6 |
| 10/22/2012 | 8.10 | 18.2 |
| 10/23/2012 | 7.61 | 18.3 |
| 10/24/2012 | 7.62 | 19.0 |
| 10/25/2012 | 7.65 | 19.7 |
| 10/26/2012 | 7.76 | 19.9 |
| 10/27/2012 | 7.14 | 20.0 |
| 10/28/2012 | 7.55 | 19.7 |
| 10/29/2012 | 7.86 | 20.4 |
| 10/30/2012 | 7.77 | 17.4 |
| 10/31/2012 | 7.52 | 16.7 |
| 11/1/2012 | 7.61 | 16.1 |
| 11/2/2012 | 7.84 | 15.9 |
| 11/3/2012 | 7.80 | 15.6 |
| 11/4/2012 | 7.80 | 15.6 |
| 11/5/2012 | 7.91 | 14.6 |
| 11/6/2012 | 7.86 | 14.0 |
| 11/7/2012 | 7.74 | 14.1 |
| 11/8/2012 | 7.76 | 13.4 |
| 11/9/2012 | 7.69 | 13.6 |
| 11/10/2012 | 7.60 | 14.1 |
| 11/11/2012 | 7.66 | 14.3 |
| 11/12/2012 | 7.66 | 15.1 |
| 11/13/2012 | 7.64 | 15.7 |
| 11/14/2012 | 7.73 | 15.1 |
| 11/15/2012 | 7.74 | 14.4 |
| 11/16/2012 | 7.86 | 14.3 |
| 11/17/2012 | 7.68 | 14.6 |
| 11/18/2012 | 7.72 | 13.7 |
| 11/19/2012 | 8.32 | 13.4 |
| 11/20/2012 | 7.93 | 13.7 |
| 11/21/2012 | 7.95 | 12.9 |
| 11/22/2012 | 7.81 | 12.1 |
| 11/23/2012 | 7.98 | 11.8 |
| 11/24/2012 | 7.79 | 11.4 |
| 11/25/2012 | 7.62 | 10.6 |
| 11/26/2012 | 7.57 | 10.2 |
| 11/27/2012 | 7.72 | 10.7 |
| 11/28/2012 | 7.71 | 10.6 |
| 11/29/2012 | 7.69 | 10.4 |
| 11/30/2012 | 7.72 | 10.7 |
| 12/1/2012 | 7.56 | 11.1 |
| 12/2/2012 | 7.56 | 11.3 |
| 12/3/2012 | 7.75 | 12.5 |

**pH/Temp Effluent Data**

**Madeira School WWTP (VA0024121)**

**January 2011 -- December 2012**

| | | |
|---|---|---|
| 12/4/2012 | 7.69 | 13.5 |
| 12/5/2012 | 7.59 | 14.4 |
| 12/6/2012 | 7.69 | 13.4 |
| 12/7/2012 | 7.80 | 13.1 |
| 12/8/2012 | 7.77 | 13.7 |
| 12/9/2012 | 7.82 | 14.2 |
| 12/10/2012 | 7.61 | 14.6 |
| 12/11/2012 | 7.85 | 14.6 |
| 12/12/2012 | 7.74 | 13.9 |
| 12/13/2012 | 7.74 | 13.4 |
| 12/14/2012 | 7.81 | 12.3 |
| 12/15/2012 | 7.50 | 12.5 |
| 12/16/2012 | 7.52 | 14.2 |
| 12/17/2012 | 7.97 | 13.3 |
| 12/18/2012 | 8.01 | 13.9 |
| 12/19/2012 | 7.93 | 12.9 |
| 12/20/2012 | 7.87 | 13.0 |
| 12/21/2012 | 8.04 | 12.5 |
| 12/22/2012 | 7.74 | 11.7 |
| 12/23/2012 | 7.77 | 10.7 |
| 12/24/2012 | 7.80 | 10.3 |
| 12/25/2012 | 7.94 | 10.3 |
| 12/26/2012 | 7.70 | 10.0 |
| 12/27/2012 | 7.82 | 9.6 |
| 12/28/2012 | 7.94 | 9.1 |
| 12/29/2012 | 7.94 | 9.2 |
| 12/30/2012 | 7.70 | 9.2 |
| 12/31/2012 | 7.66 | 7.9 |
| **90th Percentile** | **7.98** | **24.6** |
| **10th Percentile** | **7.51** | **9** |

# FRESHWATER
# WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

**Attachment 6**

Facility Name: Madeira School  Permit No.: VA0024121

Receiving Stream: Difficult Run, UT  Version: OWP Guidance Memo 00-2011 (8/24/00)

| Stream Information | | Stream Flows | | Mixing Information | | Effluent Information | |
|---|---|---|---|---|---|---|---|
| Mean Hardness (as CaCO3) = | mg/L | 1Q10 (Annual) = | 0 MGD | Annual - 1Q10 Mix = | 0 % | Mean Hardness (as CaCO3) = | 143 mg/L |
| 90% Temperature (Annual) = | deg C | 7Q10 (Annual) = | 0 MGD | - 7Q10 Mix = | 0 % | 90% Temp (Annual) = | 24.6 deg C |
| 90% Temperature (Wet season) = | deg C | 30Q10 (Annual) = | 0 MGD | - 30Q10 Mix = | 0 % | 90% Temp (Wet season) = | 15 deg C |
| 90% Maximum pH = | SU | 1Q10 (Wet season) = | 0 MGD | Wet Season - 1Q10 Mix = | 0 % | 90% Maximum pH = | 7.98 SU |
| 10% Maximum pH = | SU | 30Q10 (Wet season) | 0 MGD | - 30Q10 Mix = | 0 % | 10% Maximum pH = | 7.51 SU |
| Tier Designation (1 or 2) = | 1 | 30Q5 = | 0 MGD | | | Discharge Flow = | 0.0495 MGD |
| Public Water Supply (PWS) Y/N? = | n | Harmonic Mean = | 0 MGD | | | | |
| Trout Present Y/N? = | n | | | | | | |
| Early Life Stages Present Y/N? = | y | | | | | | |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | Most Limiting Allocations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH |
| Acenapthene | 0 | -- | -- | na | 9.9E+02 | -- | -- | na | 9.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 9.9E+02 |
| Acrolein | 0 | -- | -- | na | 9.3E+00 | -- | -- | na | 9.3E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 9.3E+00 |
| Acrylonitrile [C] | 0 | -- | -- | na | 2.5E+00 | -- | -- | na | 2.5E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.5E+00 |
| Aldrin [C] | 0 | 3.0E+00 | -- | na | 5.0E-04 | 3.0E+00 | -- | na | 5.0E-04 | -- | -- | -- | -- | -- | -- | -- | -- | 3.0E+00 | -- | na | 5.0E-04 |
| Ammonia-N (mg/l) (Yearly) | 0 | 8.73E+00 | 1.31E+00 | na | -- | 8.73E+00 | 1.31E+00 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.73E+00 | 1.31E+00 | na | -- |
| Ammonia-N (mg/l) (High Flow) | 0 | 8.73E+00 | 2.43E+00 | na | -- | 8.73E+00 | 2.43E+00 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.73E+00 | 2.43E+00 | na | -- |
| Anthracene | 0 | -- | -- | na | 4.0E+04 | -- | -- | na | 4.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 4.0E+04 |
| Antimony | 0 | -- | -- | na | 6.4E+02 | -- | -- | na | 6.4E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 6.4E+02 |
| Arsenic | 0 | 3.4E+02 | 1.5E+02 | na | -- | 3.4E+02 | 1.5E+02 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.4E+02 | 1.5E+02 | na | -- |
| Barium | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Benzene [C] | 0 | -- | -- | na | 5.1E+02 | -- | -- | na | 5.1E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 5.1E+02 |
| Benzidine [C] | 0 | -- | -- | na | 2.0E-03 | -- | -- | na | 2.0E-03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.0E-03 |
| Benzo (a) anthracene [C] | 0 | -- | -- | na | 1.8E-01 | -- | -- | na | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E-01 |
| Benzo (b) fluoranthene [C] | 0 | -- | -- | na | 1.8E-01 | -- | -- | na | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E-01 |
| Benzo (k) fluoranthene [C] | 0 | -- | -- | na | 1.8E-01 | -- | -- | na | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E-01 |
| Benzo (a) pyrene [C] | 0 | -- | -- | na | 1.8E-01 | -- | -- | na | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E-01 |
| Bis2-Chloroethyl Ether [C] | 0 | -- | -- | na | 5.3E+00 | -- | -- | na | 5.3E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 5.3E+00 |
| Bis2-Chloroisopropyl Ether | 0 | -- | -- | na | 6.5E+04 | -- | -- | na | 6.5E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 6.5E+04 |
| Bis 2-Ethylhexyl Phthalate [C] | 0 | -- | -- | na | 2.2E+01 | -- | -- | na | 2.2E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.2E+01 |
| Bromoform [C] | 0 | -- | -- | na | 1.4E+03 | -- | -- | na | 1.4E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.4E+03 |
| Butylbenzylphthalate | 0 | -- | -- | na | 1.9E+03 | -- | -- | na | 1.9E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.9E+03 |
| Cadmium | 0 | 5.9E+00 | 1.5E+00 | na | -- | 5.9E+00 | 1.5E+00 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5.9E+00 | 1.5E+00 | na | -- |
| Carbon Tetrachloride [C] | 0 | -- | -- | na | 1.6E+01 | -- | -- | na | 1.6E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.6E+01 |
| Chlordane [C] | 0 | 2.4E+00 | 4.3E-03 | na | 8.1E-03 | 2.4E+00 | 4.3E-03 | na | 8.1E-03 | -- | -- | -- | -- | -- | -- | -- | -- | 2.4E+00 | 4.3E-03 | na | 8.1E-03 |
| Chloride | 0 | 8.6E+05 | 2.3E+05 | na | -- | 8.6E+05 | 2.3E+05 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.6E+05 | 2.3E+05 | na | -- |
| TRC | 0 | 1.9E+01 | 1.1E+01 | na | -- | 1.9E+01 | 1.1E+01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.9E+01 | 1.1E+01 | na | -- |
| Chlorobenzene | 0 | -- | -- | na | 1.6E+03 | -- | -- | na | 1.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.6E+03 |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | Most Limiting Allocations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH |
| Chlorodibromomethane[C] | 0 | -- | -- | na | 1.3E+02 | -- | -- | na | 1.3E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.3E+02 |
| Chloroform | 0 | -- | -- | na | 1.1E+04 | -- | -- | na | 1.1E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.1E+04 |
| 2-Chloronaphthalene | 0 | -- | -- | na | 1.6E+03 | -- | -- | na | 1.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.6E+03 |
| 2-Chlorophenol | 0 | -- | -- | na | 1.5E+02 | -- | -- | na | 1.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.5E+02 |
| Chlorpyrifos | 0 | 8.3E-02 | 4.1E-02 | na | -- | 8.3E-02 | 4.1E-02 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.3E-02 | 4.1E-02 | na | -- |
| Chromium III | 0 | 7.6E+02 | 9.9E+01 | na | -- | 7.6E+02 | 9.9E+01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7.6E+02 | 9.9E+01 | na | -- |
| Chromium VI | 0 | 1.6E+01 | 1.1E+01 | na | -- | 1.6E+01 | 1.1E+01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.6E+01 | 1.1E+01 | na | -- |
| Chromium, Total | 0 | -- | -- | 1.0E+02 | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Chrysene[C] | 0 | -- | -- | na | 1.8E-02 | -- | -- | na | 1.8E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E-02 |
| Copper | 0 | 1.9E+01 | 1.2E+01 | na | -- | 1.9E+01 | 1.2E+01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.9E+01 | 1.2E+01 | na | -- |
| Cyanide, Free | 0 | 2.2E+01 | 5.2E+00 | na | 1.6E+04 | 2.2E+01 | 5.2E+00 | na | 1.6E+04 | -- | -- | -- | -- | -- | -- | -- | -- | 2.2E+01 | 5.2E+00 | na | 1.6E+04 |
| DDD[C] | 0 | -- | -- | na | 3.1E-03 | -- | -- | na | 3.1E-03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 3.1E-03 |
| DDE[C] | 0 | -- | -- | na | 2.2E-03 | -- | -- | na | 2.2E-03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.2E-03 |
| DDT[C] | 0 | 1.1E+00 | 1.0E-03 | na | 2.2E-03 | 1.1E+00 | 1.0E-03 | na | 2.2E-03 | -- | -- | -- | -- | -- | -- | -- | -- | 1.1E+00 | 1.0E-03 | na | 2.2E-03 |
| Demeton | 0 | -- | 1.0E-01 | na | -- | -- | 1.0E-01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0E-01 | na | -- |
| Diazinon | 0 | 1.7E-01 | 1.7E-01 | na | -- | 1.7E-01 | 1.7E-01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.7E-01 | 1.7E-01 | na | -- |
| Dibenz(a,h)anthracene[C] | 0 | -- | -- | na | 1.8E-01 | -- | -- | na | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E-01 |
| 1,2-Dichlorobenzene | 0 | -- | -- | na | 1.3E+03 | -- | -- | na | 1.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.3E+03 |
| 1,3-Dichlorobenzene | 0 | -- | -- | na | 9.6E+02 | -- | -- | na | 9.6E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 9.6E+02 |
| 1,4-Dichlorobenzene | 0 | -- | -- | na | 1.9E+02 | -- | -- | na | 1.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.9E+02 |
| 3,3-Dichlorobenzidine[C] | 0 | -- | -- | na | 2.8E-01 | -- | -- | na | 2.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.8E-01 |
| Dichlorobromomethane[C] | 0 | -- | -- | na | 1.7E+02 | -- | -- | na | 1.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.7E+02 |
| 1,2-Dichloroethane[C] | 0 | -- | -- | na | 3.7E+02 | -- | -- | na | 3.7E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 3.7E+02 |
| 1,1-Dichloroethylene | 0 | -- | -- | na | 7.1E+03 | -- | -- | na | 7.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 7.1E+03 |
| 1,2-trans-dichloroethylene | 0 | -- | -- | na | 1.0E+04 | -- | -- | na | 1.0E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.0E+04 |
| 2,4-Dichlorophenol | 0 | -- | -- | na | 2.9E+02 | -- | -- | na | 2.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.9E+02 |
| 2,4-Dichlorophenoxy acetic acid (2,4-D) | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| 1,2-Dichloropropane[C] | 0 | -- | -- | na | 1.5E+02 | -- | -- | na | 1.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.5E+02 |
| 1,3-Dichloropropene[C] | 0 | -- | -- | na | 2.1E+02 | -- | -- | na | 2.1E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.1E+02 |
| Dieldrin[C] | 0 | 2.4E-01 | 5.6E-02 | na | 5.4E-04 | 2.4E-01 | 5.6E-02 | na | 5.4E-04 | -- | -- | -- | -- | -- | -- | -- | -- | 2.4E-01 | 5.6E-02 | na | 5.4E-04 |
| Diethyl Phthalate | 0 | -- | -- | na | 4.4E+04 | -- | -- | na | 4.4E+04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 4.4E+04 |
| 2,4-Dimethylphenol | 0 | -- | -- | na | 8.5E+02 | -- | -- | na | 8.5E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 8.5E+02 |
| Dimethyl Phthalate | 0 | -- | -- | na | 1.1E+06 | -- | -- | na | 1.1E+06 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.1E+06 |
| Di-n-Butyl Phthalate | 0 | -- | -- | na | 4.5E+03 | -- | -- | na | 4.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 4.5E+03 |
| 2,4 Dinitrophenol | 0 | -- | -- | na | 5.3E+03 | -- | -- | na | 5.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 5.3E+03 |
| 2-Methyl-4,6-Dinitrophenol | 0 | -- | -- | na | 2.8E+02 | -- | -- | na | 2.8E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.8E+02 |
| 2,4-Dinitrotoluene[C] | 0 | -- | -- | na | 3.4E+01 | -- | -- | na | 3.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 3.4E+01 |
| Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin | 0 | -- | -- | na | 5.1E-08 | -- | -- | na | 5.1E-08 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 5.1E-08 |
| 1,2-Diphenylhydrazine[C] | 0 | -- | -- | na | 2.0E+00 | -- | -- | na | 2.0E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.0E+00 |
| Alpha-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | na | 8.9E+01 | 2.2E-01 | 5.6E-02 | na | 8.9E+01 | -- | -- | -- | -- | -- | -- | -- | -- | 2.2E-01 | 5.6E-02 | na | 8.9E+01 |
| Beta-Endosulfan | 0 | 2.2E-01 | 5.6E-02 | na | 8.9E+01 | 2.2E-01 | 5.6E-02 | na | 8.9E+01 | -- | -- | -- | -- | -- | -- | -- | -- | 2.2E-01 | 5.6E-02 | na | 8.9E+01 |
| Alpha + Beta Endosulfan | 0 | 2.2E-01 | 5.6E-02 | -- | -- | 2.2E-01 | 5.6E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.2E-01 | 5.6E-02 | -- | -- |
| Endosulfan Sulfate | 0 | -- | -- | na | 8.9E+01 | -- | -- | na | 8.9E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 8.9E+01 |
| Endrin | 0 | 8.6E-02 | 3.6E-02 | na | 6.0E-02 | 8.6E-02 | 3.6E-02 | na | 6.0E-02 | -- | -- | -- | -- | -- | -- | -- | -- | 8.6E-02 | 3.6E-02 | na | 6.0E-02 |
| Endrin Aldehyde | 0 | -- | -- | na | 3.0E-01 | -- | -- | na | 3.0E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 3.0E-01 |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | Most Limiting Allocations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH |
| Ethylbenzene | 0 | -- | -- | na | 2.1E+03 | -- | -- | na | 2.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.1E+03 |
| Fluoranthene | 0 | -- | -- | na | 1.4E+02 | -- | -- | na | 1.4E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.4E+02 |
| Fluorene | 0 | -- | -- | na | 5.3E+03 | -- | -- | na | 5.3E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 5.3E+03 |
| Foaming Agents | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Guthion | 0 | -- | 1.0E-02 | na | -- | -- | 1.0E-02 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0E-02 | na | -- |
| Heptachlor [C] | 0 | 5.2E-01 | 3.8E-03 | na | 7.9E-04 | 5.2E-01 | 3.8E-03 | na | 7.9E-04 | -- | -- | -- | -- | -- | -- | -- | -- | 5.2E-01 | 3.8E-03 | na | 7.9E-04 |
| Heptachlor Epoxide [C] | 0 | 5.2E-01 | 3.8E-03 | na | 3.9E-04 | 5.2E-01 | 3.8E-03 | na | 3.9E-04 | -- | -- | -- | -- | -- | -- | -- | -- | 5.2E-01 | 3.8E-03 | na | 3.9E-04 |
| Hexachlorobenzene [C] | 0 | -- | -- | na | 2.9E-03 | -- | -- | na | 2.9E-03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 2.9E-03 |
| Hexachlorobutadiene [C] | 0 | -- | -- | na | 1.8E+02 | -- | -- | na | 1.8E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E+02 |
| Hexachlorocyclohexane Alpha-BHC [C] | 0 | -- | -- | na | 4.9E-02 | -- | -- | na | 4.9E-02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 4.9E-02 |
| Hexachlorocyclohexane Beta-BHC [C] | 0 | -- | -- | na | 1.7E-01 | -- | -- | na | 1.7E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.7E-01 |
| Hexachlorocyclohexane Gamma-BHC [C] (Lindane) | 0 | 9.5E-01 | na | na | 1.8E+00 | 9.5E-01 | -- | na | 1.8E+00 | -- | -- | -- | -- | -- | -- | -- | -- | 9.5E-01 | -- | na | 1.8E+00 |
| Hexachlorocyclopentadiene | 0 | -- | -- | na | 1.1E+03 | -- | -- | na | 1.1E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.1E+03 |
| Hexachloroethane [C] | 0 | -- | -- | na | 3.3E+01 | -- | -- | na | 3.3E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 3.3E+01 |
| Hydrogen Sulfide | 0 | -- | 2.0E+00 | na | -- | -- | 2.0E+00 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0E+00 | na | -- |
| Indeno (1,2,3-cd) pyrene [C] | 0 | -- | -- | na | 1.8E-01 | -- | -- | na | 1.8E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.8E-01 |
| Iron | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Isophorone [C] | 0 | -- | -- | na | 9.6E+03 | -- | -- | na | 9.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 9.6E+03 |
| Kepone | 0 | -- | 0.0E+00 | na | -- | -- | 0.0E+00 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.0E+00 | na | -- |
| Lead | 0 | 1.9E+02 | 2.1E+01 | na | -- | 1.9E+02 | 2.1E+01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.9E+02 | 2.1E+01 | na | -- |
| Malathion | 0 | -- | 1.0E-01 | na | -- | -- | 1.0E-01 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0E-01 | na | -- |
| Manganese | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Mercury | 0 | 1.4E+00 | 7.7E-01 | -- | -- | 1.4E+00 | 7.7E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.4E+00 | 7.7E-01 | -- | -- |
| Methyl Bromide | 0 | -- | -- | na | 1.5E+03 | -- | -- | na | 1.5E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 1.5E+03 |
| Methylene Chloride [C] | 0 | -- | -- | na | 5.9E+03 | -- | -- | na | 5.9E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 5.9E+03 |
| Methoxychlor | 0 | -- | 3.0E-02 | na | -- | -- | 3.0E-02 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0E-02 | na | -- |
| Mirex | 0 | -- | 0.0E+00 | na | -- | -- | 0.0E+00 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.0E+00 | na | -- |
| Nickel | 0 | 2.5E+02 | 2.7E+01 | na | 4.6E+03 | 2.5E+02 | 2.7E+01 | na | 4.6E+03 | -- | -- | -- | -- | -- | -- | -- | -- | 2.5E+02 | 2.7E+01 | na | 4.6E+03 |
| Nitrate (as N) | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Nitrobenzene | 0 | -- | -- | na | 6.9E+02 | -- | -- | na | 6.9E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 6.9E+02 |
| N-Nitrosodimethylamine [C] | 0 | -- | -- | na | 3.0E+01 | -- | -- | na | 3.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 3.0E+01 |
| N-Nitrosodiphenylamine [C] | 0 | -- | -- | na | 6.0E+01 | -- | -- | na | 6.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 6.0E+01 |
| N-Nitrosodi-n-propylamine [C] | 0 | -- | -- | na | 5.1E+00 | -- | -- | na | 5.1E+00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 5.1E+00 |
| Nonylphenol | 0 | 2.8E+01 | 6.6E+00 | -- | -- | 2.8E+01 | 6.6E+00 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.8E+01 | 6.6E+00 | na | -- |
| Parathion | 0 | 6.5E-02 | 1.3E-02 | na | -- | 6.5E-02 | 1.3E-02 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6.5E-02 | 1.3E-02 | na | -- |
| PCB Total [C] | 0 | -- | 1.4E-02 | na | 6.4E-04 | -- | 1.4E-02 | na | 6.4E-04 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.4E-02 | na | 6.4E-04 |
| Pentachlorophenol [C] | 0 | 1.5E+01 | 1.1E+01 | na | 3.0E+01 | 1.5E+01 | 1.1E+01 | na | 3.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | 1.5E+01 | 1.1E+01 | na | 3.0E+01 |
| Phenol | 0 | -- | -- | na | 8.6E+05 | -- | -- | na | 8.6E+05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 8.6E+05 |
| Pyrene | 0 | -- | -- | na | 4.0E+03 | -- | -- | na | 4.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | 4.0E+03 |
| Radionuclides | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Gross Alpha Activity (pCi/L) | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Beta and Photon Activity (mrem/yr) | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Radium 226 + 228 (pCi/L) | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Uranium (ug/l) | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |

| Parameter | Background | Water Quality Criteria | | | | Wasteload Allocations | | | | Antidegradation Baseline | | | | Antidegradation Allocations | | | | Most Limiting Allocations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (ug/l unless noted) | Conc. | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH | Acute | Chronic | HH (PWS) | HH |
| Selenium, Total Recoverable | 0 | 2.0E+01 | 5.0E+00 | na | 4.2E+03 | 2.0E+01 | 5.0E+00 | na | 4.2E+03 | -- | -- | -- | -- | -- | -- | -- | -- | **2.0E+01** | **5.0E+00** | **na** | **4.2E+03** |
| Silver | 0 | 6.4E+00 | -- | na | -- | 6.4E+00 | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | **6.4E+00** | -- | **na** | -- |
| Sulfate | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| 1,1,2,2-Tetrachloroethane[C] | 0 | -- | -- | na | 4.0E+01 | -- | -- | na | 4.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **4.0E+01** |
| Tetrachloroethylene[C] | 0 | -- | -- | na | 3.3E+01 | -- | -- | na | 3.3E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **3.3E+01** |
| Thallium | 0 | -- | -- | na | 4.7E-01 | -- | -- | na | 4.7E-01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **4.7E-01** |
| Toluene | 0 | -- | -- | na | 6.0E+03 | -- | -- | na | 6.0E+03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **6.0E+03** |
| Total dissolved solids | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Toxaphene [C] | 0 | 7.3E-01 | 2.0E-04 | na | 2.8E-03 | 7.3E-01 | 2.0E-04 | na | 2.8E-03 | -- | -- | -- | -- | -- | -- | -- | -- | **7.3E-01** | **2.0E-04** | **na** | **2.8E-03** |
| Tributyltin | 0 | 4.6E-01 | 7.2E-02 | na | -- | 4.6E-01 | 7.2E-02 | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | **4.6E-01** | **7.2E-02** | **na** | -- |
| 1,2,4-Trichlorobenzene | 0 | -- | -- | na | 7.0E+01 | -- | -- | na | 7.0E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **7.0E+01** |
| 1,1,2-Trichloroethane[C] | 0 | -- | -- | na | 1.6E+02 | -- | -- | na | 1.6E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **1.6E+02** |
| Trichloroethylene [C] | 0 | -- | -- | na | 3.0E+02 | -- | -- | na | 3.0E+02 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **3.0E+02** |
| 2,4,6-Trichlorophenol [C] | 0 | -- | -- | na | 2.4E+01 | -- | -- | na | 2.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **2.4E+01** |
| 2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex) | 0 | -- | -- | na | -- | -- | -- | na | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | -- |
| Vinyl Chloride[C] | 0 | -- | -- | na | 2.4E+01 | -- | -- | na | 2.4E+01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | na | **2.4E+01** |
| Zinc | 0 | 1.6E+02 | 1.6E+02 | na | 2.6E+04 | 1.6E+02 | 1.6E+02 | na | 2.6E+04 | -- | -- | -- | -- | -- | -- | -- | -- | **1.6E+02** | **1.6E+02** | **na** | **2.6E+04** |

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

| Metal | Target Value (SSTV) |
|---|---|
| Antimony | 6.4E+02 |
| Arsenic | 9.0E+01 |
| Barium | na |
| Cadmium | 9.0E-01 |
| Chromium III | 6.0E+01 |
| Chromium VI | 6.4E+00 |
| Copper | 7.3E+00 |
| Iron | na |
| Lead | 1.3E+01 |
| Manganese | na |
| Mercury | 4.6E-01 |
| Nickel | 1.6E+01 |
| Selenium | 3.0E+00 |
| Silver | 2.6E+00 |
| Zinc | 6.3E+01 |

Note: do not use QL's lower than the minimum QL's provided in agency guidance

| Madeira School WWTP -- Copper Data (VA0024121) | |
|---|---|
| March 2009 -- September 2013 | |
| | |
| **DMR Due Date** | **Average Concentration (µg/L)** |
| 10-Oct-13 | 20 |
| 10-Sep-13 | 20 |
| 10-Aug-13 | 21 |
| 10-Jul-13 | 27 |
| 10-Apr-13 | 24 |
| 10-Mar-13 | 27 |
| 10-Feb-13 | 17 |
| 10-Jan-13 | 16 |
| 10-Dec-12 | 18 |
| 10-Nov-12 | 21 |
| 10-Oct-12 | 24 |
| 10-Sep-12 | 18 |
| 10-Aug-12 | 16 |
| 10-Jul-12 | 15 |
| 10-Jun-12 | 13 |
| 10-May-12 | 15 |
| 10-Apr-12 | 13 |
| 10-Mar-12 | 15 |
| 10-Feb-12 | 12 |
| 10-Jan-12 | 14 |
| 10-Dec-11 | 14 |
| 10-Nov-11 | 15 |
| 10-Oct-11 | 19 |
| 10-Sep-11 | 17 |
| 10-Aug-11 | 19 |
| 10-Jul-11 | 23 |
| 10-Jun-11 | 24 |
| 10-May-11 | 21 |
| 10-Apr-11 | 19 |
| 10-Mar-11 | 12 |
| 10-Feb-11 | 14 |
| 10-Jan-11 | 16 |
| 10-Dec-10 | 17 |
| 10-Nov-10 | 18 |
| 10-Oct-10 | 9 |
| 10-Sep-10 | 26 |
| 10-Aug-10 | 25 |
| 10-Jul-10 | 24.5 |
| 10-Apr-10 | 17.8 |
| 10-Jan-10 | 20 |
| 10-Oct-09 | 5 |
| 10-Jul-09 | 27.6 |
| 10-Apr-09 | 16.3 |

**Attachment 7**

# APPENDIX A
# SCHEDULE OF COMPLIANCE

The Madeira School, Incorporated shall:

1. No later than October 31, 2011, submit a Water Effects Ratio (WER) Study Plan and Schedule to DEQ for review and approval.

2. Complete the WER Study in accordance with the approved schedule and in no event later than January 1, 2013. Any changes to the schedule shall be approved by DEQ in advance.

3. Within 60 days of the date of completion of the WER study submit the results to DEQ for review and approval. Any comments provided regarding the WER study submittal shall be addressed to DEQ in writing within 30 days of receipt of comments.

4. Concurrent with submittal of the WER study results, submit to DEQ a formal request to modify the VPDES permit to reflect the findings of the WER study. If the WER Study is not approved or if the study results do not support higher final effluent limits for total recoverable copper, Madeira School shall submit to DEQ for review and approval an alternative plan and schedule to comply with the conditions of the Permit. The plan and schedule shall be submitted within 60 days of written notification from DEQ.

5. Begin implementation of the plan and schedule referenced in paragraph 4 above, within 30 days of approval but no later than July 1, 2013.

6. Operate the WWTP in a workman-like manner in order to produce the best quality effluent of which the WWTP is capable during implementation of this schedule.

Correspondence required by this Order, shall be submitted to:

Department of Environmental Quality
Northern Regional Office
13901 Crown Court
Woodbridge, VA 22193
Attn: Enforcement

# DEPARTMENT OF ENVIRONMENTAL QUALITY

**SUBJECT:** **Review and Approval of Madeira School, Virginia STP Water Effect Ratio Study (VPDES Permit # VA0021421)**

**By:** Alex M. Barron

**Date:** January 24, 2013

**Summary Finding:**
The Madeira School Virginia conducted a water effect ratio (WER) study following EPA's guidelines for a streamlined copper WER study under suitable conditions and resulted in establishing a **WER of 5.984** (applied to total copper measurements) which can be used in applying the Virginia water quality criteria to the specific discharge conditions at the sewage treatment plant (STP) site. The WER can be used to adjust the Virginia acute and chronic criteria for copper and calculate the resulting waste load allocations (WLA) for this permit and will be used to make permit decisions for the need for copper discharge limits for the Madeira School STP, permit #VA0024121 which discharges into an unnamed tributary to Difficult Run, just before it discharges into the Potomac River. The receiving stream has a 7Q10 flow of 0.00 MGD at the discharge site.

**Description of study and review:**
The Madeira School is a small private school in Fairfax County Virginia with a new treatment facility installed in 2010. The new system consists of an activated sludge treatment facility with tertiary treatment and UV disinfection and permitted flow of 0.0395 MGD. The Madeira School conducted a water effect ratio (WER) study for copper in order to establish a WER that can be applied to the Virginian copper criteria equations to calculate copper criteria that would apply to the discharge from their sewage treatment plant (STP).

Virginia's water quality criteria for copper in freshwater consists of formulas to adjust the acute or chronic criteria for hardness using formulas developed and recommended by the U.S Environmental Protection Agency (EPA). The Virginia criteria formulas include a water effect ratio (WER) which is set at a default value of 1.0 unless a WER study is performed for a specific receiving stream and discharge to establish a WER for that receiving stream. The Madeira School conducted the WER study in order to establish a WER applicable to their STP's receiving stream and to their discharge permit.

The Virginia freshwater criteria formulas for copper are shown below.
**Freshwater acute criterion (µg /l)** = WER x $[_e\{0.9422[\ln(\text{hardness})]-1.700\}]$ x (CFa)

**Freshwater chronic criterion (µg/l)** = WER x $[_e\{0.8545[\ln(\text{hardness})]-1.702\}]$ x (CFc)

WER = Water Effect Ratio =1 unless shown otherwise

**Attachment 9**

under 9 VAC 25-260-140.F and listed in 9 VAC 25-260-310.
e = natural antilogarithm
ln=natural logarithm
CFa = 0.960
CFc = 0.960

**Madeira School WER Study**:
The Madeira School conducted a water effect ratio (WER) study for copper in order to establish a WER that can be applied to the Virginian copper criteria equations to calculate copper criteria that would apply to the receiving stream and to their discharge permit. This study followed the EPA guidance for a Streamlined Water-Effect Ratio Procedure for Discharges of Copper EPA-822-R-01-05 (hereafter referred to as the streamlined WER guidance). This guidance document is available at: http://epa.gov/waterscience/criteria/copper/2003/index.htm.

This streamlined WER guidance requires two sets of side-by-side WER toxicity tests, conducted at different times at least a month apart and using a representative sample of the effluent and stream water mix at permit conditions. Each WER test consists of two side-by-side toxicity tests, where the test species *Ceriodaphnia dubia* is exposed to varying concentrations of added copper to establish an $EC_{50}$ value for copper. One of the tests is conducted in clean laboratory water and another text is conducted in simulated stream water consisting of receiving stream water and effluent mixed at the conditions of the permit. The two $EC_{50}$ values for these two toxicity tests are used to calculate a water effect ratio by dividing the $EC_{50}$ value from the test with the simulated stream-water by the $EC_{50}$ value from the lab-water test. It is expected that STP discharges and/or natural waters will contain elevated levels of carbon and other suspended solids, which will absorb some of the copper and make it less toxic as compared to clean lab water. This should result in less toxicity of copper in the natural water and the WER allows us to establish the amount of adjustment that can be made to the default criteria calculations and adjusts the criteria to the specific conditions at the permitted discharge.

A review of the streamlined water effect ratio (WER) study for the Madeira School STP indicates that the set of toxicity tests conducted on April 5-7, 2012 and May 23-25, 2012 were conducted under acceptable conditions and are suitable for establishing a WER for this permitted facility. In all tests, the testing laboratory measured the concentrations of copper in the toxicity tests and calculated $EC_{50}$ values using acceptable and established methods based on total copper measurements. This allowed for the calculation of a WER that is applicable to total copper measurements and which can be used directly for establishing Permit Limits for copper that are unique to this permit. A total copper WER is appropriate for use in translating the Virginia copper criteria into permit limits, which must be expressed as total metal concentrations.

In both sets of tests the $EC_{50}$ values for the lab-water tests were lower than the species mean acute value (SMAV) based on other $EC_{50}$ values reported in the literature for the test species *Ceriodaphnia dubia*. These literature values produced the dataset used to

develop the freshwater copper criteria in the EPA criteria document and this is the default criteria used in Virginia unless a WER can be established for a specific discharge the site. This is not unusual since more recent $EC_{50}$ values lab practices in conducting toxicity tests use very clean water that contain very little binding material, resulting in lower $EC_{50}$ values compared to tests in the past (which form the basis for the EPA and Virginia criteria) where lab waters often contained some carbon or other substances that lowered the toxicity of copper, resulting in higher $EC_{50}$ values Under these circumstances (lab water $EC_{50}$ values lower than the SMAV), the Streamlined Water-Effect Ratio Procedure for Discharges of Copper specifies that instead of dividing the site-water $EC_{50}$ value by the lab-water $EC_{50}$ value, the SMAV must be used as the denominator in calculating the WER. This is done to keep the WER comparable to the established criteria values. Following the EPA's streamlined WER guidance (on page 13 and Appendix B page 17), the SMAV of 6.501 µg/L (at a hardness of 25 mg/L) as reported in the EPA streamlined WER guidance was used to establish the WER for this discharge and receiving stream. Before calculating the WERs, the LC50 values from the toxicity tests and SMAVs from the EPA streamlined WER guidance (Appendix B page 17) were normalized to the same reference hardness level. The hardness level usually corresponding to the hardness of the site-water test is used as the basis for the normalization, but as long as both the site-water test LC50 value and the SMAV are normalized to the same hardness, the WER results will be the same. The normalized EC50 values were divided by the reference SMAV ug/L to produce the WER. The hardness normalization was done using the following formula as described in EPA's streamlined WER guidance (page 13);

$EC_{50}$ at standard hardness =

$EC_{50 \text{ at sample hardness}} \times (\text{standard hardness} / \text{sample hardness})^{0.9422}$

**DEQ Makes a Slight Adjustment to the Original Report's Conclusions and Recommendations**:

The original report, in section "H. Interpretation of WER Results" in Table 4 on page 13 of 13 presented the final, original EC50 concentrations for study 1 and study 2, along with the EC 50 concentrations after being normalized to a common hardness level based on the hardness of the "site water" tests. For Study 1, the WER value is based on the EC50 values for total copper measurements in the site water test, which was conducted at a hardness value of 138, divided by the EPA reported Species Mean Acute Value (SMAV) after it was normalized to a common hardness value of 138 to mimic the conditions in the site water test. Table 4 reports that the Study 1 (April) tests produced a total-copper WER of 6.921 and I have independently verified this as being correct.

There is a small rounding error in the original report regarding the conversion of the results of the May test results to a different hardness value. In Appendix 5, page 3 of 7 also reported the LC50 value for the May site water test as 170.5 µg/L total copper at a hardness of 140 mg/L which was converted to 175.7 µg/L total copper at a hardness of 144.( the hardness of the study's Lab Water test). The report also reports converting the

SMAV to 33.84 µg/L total copper at the same hardness of 144, and then calculates a WER as 175.7/ 33.84 = WER 5.192. This is slightly inaccurate due to an apparent small difference in the hardness-normalization in the site-water LC50 value.

My independent calculations of this hardness conversion for the May site water test LC50 value 170.5 (at hardness 140) is converted 175.0861 (at a hardness of 144) which I rounded to 175.1. This is in contrast to the original report converting this value to 175.7. Using my calculations of this site-water LC50 value and the SMAV (both normalized to a hardness of 144) results in a site water LC50 of 175.1/ SMAV of 33.84 = **WER 5.174** (instead of the original reported value of a WER of 5.192).

Standard practices in intermediate calculations of criteria follow the convention of rounding intermediate values (such as a WER) to four significant digits, and the final criterion value is rounded to two digits.

**In Summary**:
**The April test produced a WER of 6.921**.
(The site-water LC50 value of 225.0 µg/L at a hardness of 138 / EPA's SMAV of 32.51 µg/L (normalized to a hardness of 138) = **WER of 6.921**.)

**The May test produced a WER of 5.174.**
(The site-water LC50 value was reported to be 170.5 µg/L at a hardness of 140. This site-water LC50 value and the EPA SMAV were both normalized to a hardness of 144 and the WER calculation is; 175.7 / 33.84 = **WER of 5.174)**.

The geometric mean of these two WER values (6.921 and 5.174) is;
**The Final WER = 5.984**.

This is within the range of other copper WERs established in other STP-effluent-dominated streams where WERs have ranged from 2.593 to 15.7.

**Notes on WER Values Greater Than 5.0:**
The consultant's report, in section H on page 13 of 13 makes a reference to a "maximum allowable WER of 5.0". This is apparently a reference to guidance originally included in the 1994 Interim Guidance on Determination and Use of Water-Effect Ratios for Metals. EPA-823-B-94-001, where on page 61 there is some guidance on issues to investigate if the WER is larger than 5. This is not a prohibition on the use of WERs greater than 5; it is just guidance that when a WER is greater than 5, then there are some issues to be investigated in considering the appropriateness of a WER greater than 5.0. This concern for a WER greater than 5.0 and the guidance for additional investigation is not included in the 2001 Streamlined Water-Effect Ratio Procedure for Discharges of Copper, which is the basis for the current study for the Madeira School and the issues raised by the 1994 guidance have been addressed by the 2001 guidance, as discussed below.

The issues raised in the 1994 Interim Guidance are based on whether the metal is likely to be affected by elevated levels of suspended solids and/or organic carbon (if so, and the site water contained these, then this can explain the elevated WER). It is well known that the toxicity of copper is significantly affected by suspended solids and/or organic carbon and site water with elevated levels of these components can be expected to have elevated WERs, so this is not an unexpected situation with copper in streams that are dominated by sewage discharges. This is one of the reasons for EPA developing the streamlined WER procedure specifically for copper, to allow for a streamlined, less intensive WER study process because of the basic understanding of how natural waters can affect the toxicity of copper. The 2001 streamlined procedure for copper-WER takes this into account and is based on this basic understanding of copper toxicity.

Another issue raised in the 1994 guidance involved concerns the potential for lab-water $LC_{50}$ values that may be lower than previously reported values or below the SMAV used in the derivation of the criteria. This situation could artificially increase the WER and make it less comparable to the criteria equations which are based on $LC_{50}$ values that support the SMAV. This issue is also addressed in the 2001 streamlined copper-WER procedure which includes the stipulation that in such a case, the SMAV (normalized to the appropriate hardness) be used in calculating the WER. The consultant correctly used this approach in the report for the Madeira School WER study.

Since these issues are addressed by the streamlined copper-WER procedure, and for copper, and this 2001 WER guidance specifically designed for copper supersedes the 1994 interim guidance for WERs for metals in general, these concerns have essentially been addressed by the later 2001 streamlined copper-WER guidance and are no longer of concern if the 2001 streamlined copper WER procedure is used. The streamlined copper WER guidance does not set a maximum allowable WER for copper and I have no reason to not follow this guidance. **I therefore recommend that the correctly calculated final WER of 5.984 be used in permit decisions regarding this discharge**.

This WER of 5.984 can be used to adjust the Virginia copper criteria for purposes of assessing the need for total recoverable copper permit limits for the Madeira School, Virginia waste water treatment plant as it discharges into the receiving stream. This WER is unitless and is multiplied by Virginia copper criteria (as adjusted to the hardness level appropriate for this permit) to adjust the criteria to account for the local water characteristics at the site of this permitted discharge. The permit specific copper criteria for this discharge become;

**Freshwater acute criterion (µg /l) = 5.984 x $[e\{0.9422[\ln(\text{hardness})]-1.700\}]$ x 0.960**

**Freshwater chronic criterion (µg/l) = 5.984 x $[e\{0.8545[\ln(\text{hardness})]-1.702\}]$ x 0.960**

The original $EC_{50}$ values from the two tests from April and May 2012, as well as the SMAV values after being normalized to the hardness level corresponding to the site-water toxicity test and the resulting WERs are shown in Table 1 attached below.

The WER can be used with any hardness that is considered appropriate for the Madeira School STP effluent without any need for any adjustments. Once a WER is calculated based on a site-water $EC_{50}$ value and SMAV concentration normalized to equal hardness levels, the WER value is the same regardless of the hardness used in calculating a criterion value. It is simply a unitless adjustment factor in the criterion equation.

**DEQ Review and Approval of WER by DEQ**:
The Virginia Department of Environmental Quality's Water Quality Standards Unit has reviewed this study and **approves the use of a total copper WER of 5.984** to adjust the copper criteria as it applies to the Madeira School's STP permit and receiving stream, an unnamed tributary to Difficult Run in Fairfax County, Virginia. This total copper WER of will be used to adjust the copper criteria and calculate the resulting waste load allocations (WLA) for this permit and will be used to make permit decisions for the need for copper discharge limits for the Madeira School STP.

**WER public participation and application in permits procedure:**
The Virginia water Quality Standards (WQS) allow for a permittee to demonstrate that a WER is appropriate for their discharge and receiving stream. The WQS Regulation at 9VAC 25-260-140.F.4 states that the WER shall be subject to the public participation requirements of the Permit Regulation and described in the public notice of the permit proceedings. DEQ action to approve or disapprove a WER applicable to a permittee is a case decision rather than an amendment to the WQS. Decisions regarding WERs are subject to the public participation requirements of the Permit Regulation. In the past, the U.S. Environmental Protection Agency (EPA) technically viewed a WER as a site-specific criterion. However, because Virginia has incorporated the allowance for a WER in the Water Quality Standards regulation as part of the formula for the copper criteria, and because EPA has approved this form of the criteria, EPA does not have to (and will not) officially approve each individual WER, but they require that that the public be given the opportunity to comment on the use of the WER in a permit.

As long as the WER is the established following EPA and DEQ recommended protocols (as is the case for the Madeira School STP) and the study has been reviewed and approved by DEQ, the WER can be considered scientifically valid and can be used to apply the Virginia criteria for copper in an individual permit. DEQ will supply copies of the WER study and the review materials to EPA as a courtesy to keep them informed, but EPA does not have a need to officially approve individual WERs.

**Public Participation and Review**:
To satisfy the public participation requirements and give the public the opportunity to comment on the WER, the WER-modified copper criteria can be subjected to public participations via a permit related comment period, either via a permit re-issuance or permit modification.

**In Summary, Final WER:**
The final WER to be used to calculate total copper permit limits for the Madeira School STP is the geometric mean of the two WER values 6.921 and 5.174 = **Final WER 5.984**

Table 1;
Summary of all $EC_{50}$ values from the Madeira School STP WER studies; showing lab water values and SMAVs normalized to a standard hardness level.

| **Test Description** | | **EC50 (total copper)** | | **EC50 (total copper) (Normalized to equal hardness)** |
|---|---|---|---|---|
| **April 5-7 2012; Lab water** (hardness 138 mg/L) | | **18.82 µg/L** | | **18.82 µg/L (@ 138 hardness)** |
| **April 5-7 2012**; (138 hardness mg/L) **simulated stream water test** | | **225.0 µg/L** | | **225.0 µg/L (@ 138 hardness)** |
| ***Ceriodaphnia. dubia* SMAV at hardness 50 = 12.49 µg/L: (see EPA Cu-WER Guidance, page 17)** | | | **Total Cu *C. dubia* SMAV (Normalized to hardness 138 mg/L)** | **32.51 µg/L L (@ 138 hardness)** |
| **May 23-25, 2012; Lab water** (hardness = 144) | | **20.07 µg/L** | | **20.07 µg/L L (@ 144 hardness)** |
| **May 23-25, 2012;** (hardness = 140) **simulated stream water test** | | **170.5 µg/L** | | **175.1 µg/L (@ 144 hardness)** |
| **Species Mean Acute Value ( SMAV) (see EPA Cu-WER Guidance, page 17)** | | | | |
| ***Ceriodaphnia. dubia* SMAV at hardness 25 = 6.501 µg/L : (see EPA Cu-WER Guidance, page 17)** | | | **Total Cu *C. dubia* SMAV (Normalized to hardness 144 mg/L)** | **33.84 µg/L L (@ 144 hardness)** |
| | | | | |
| **WERs:** | | **Total Cu WER** | | |
| **April 5-7 2012WER** (using SMAV normalized to hardness @ 50 mg/L) | **225.0 µg/L / 32.51 µg/L** | **= 6.921** | | |
| **May 23-25, 2012 WER** (using SMAV normalized to hardness @ 50 mg/L) | **175.1 µg/L / 33.84 µg/L** | **= 5.174** | | |
| | | **Final WER (total copper)** | | |
| **Final WER (geometric mean of both WERs)** | | **5.984** | | |

ESS
Environmental Systems Service, Ltd.

October 29, 2012

Mr. Ed Stuart
Department of Environmental Quality
Northern Regional Office
13901 Crown Court
Woodbridge, VA 22193

Subject: The Madeira School WWTP VPDES Permit No. VA0024121
Copper Limit Compliance Strategy Water Effects Ratio Study

Dear Mr. Stuart,

In accordance with the DEQ-NRO approval to proceed with the Water Effects Ratio (WER) Study for The Madeira School WWTP, ESS has enclosed the WER Study Final Report which was conducted in 2012. This study was completed as part of the planned copper compliance strategy for The Madeira School VPDES Permit No. VA0024121. Enclosed are two (2) copies of the completed WER Study. Additionally, ESS will submit a separate copy to be sent to Mr. Alex Barron at DEQ Central Office and send the last copy to The Madeira School.

Should you have questions or comments, please feel free to contact me at 540-825-6660.

Best regards,

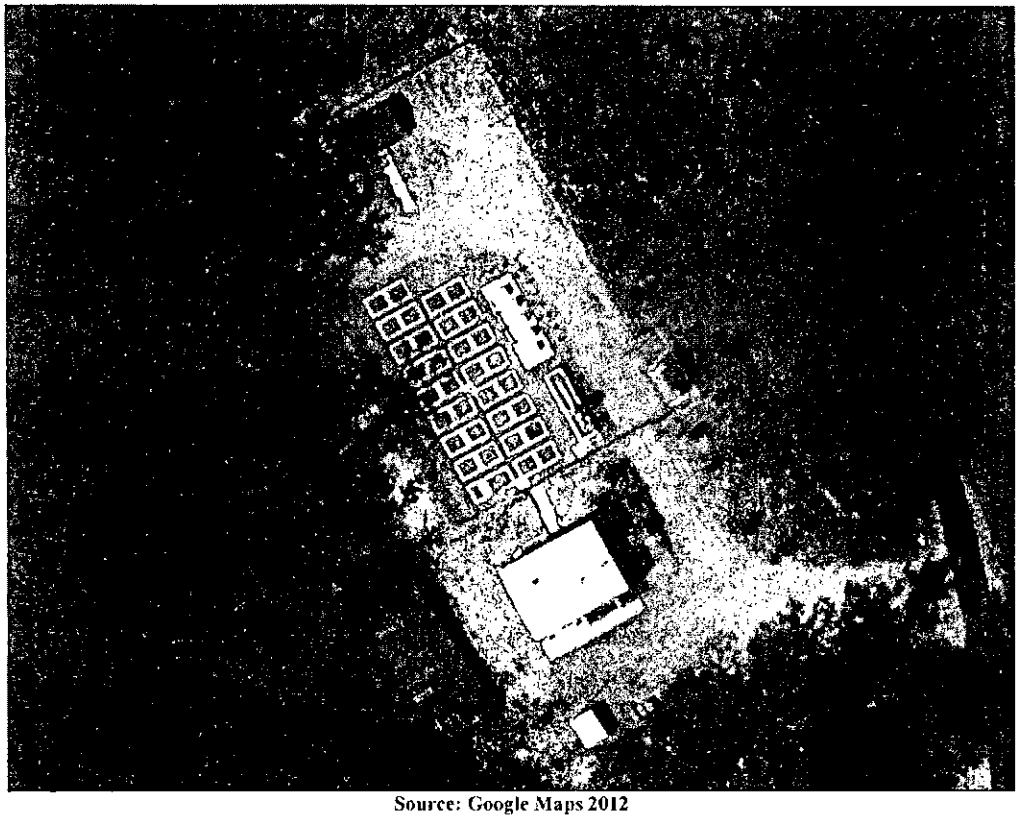
Cody J. Hoehna, Operations Manager
Environmental Services Division

Cc: Mr. Ed Hamer, The Madeira School
Mr. Alex Barron, DEQ Central Office
Ms. Rebecca Johnson, DEQ-NRO
Mr. Dan Burstein, DEQ-NRO
Ms. Anna Westernik, DEQ-NRO

Enclosure

# The Madeira School
## Wastewater Treatment Plant
## VPDES Permit No. VA0024121

## Copper Limit Compliance Strategy
## Water Effects Ratio Study



Source: Google Maps 2012

**Prepared for,**
**Virginia Department of Environmental Quality**

**Prepared by,**
**Environmental Systems Service, Ltd.**

**October 29, 2012**

# The Madeira School WWTP
# Copper Limit Compliance Strategy:
# Water Effects Ratio Study

## Table of Contents

# The Madeira School WWTP
## Copper Limit Compliance Strategy:
## Water Effects Ratio Study

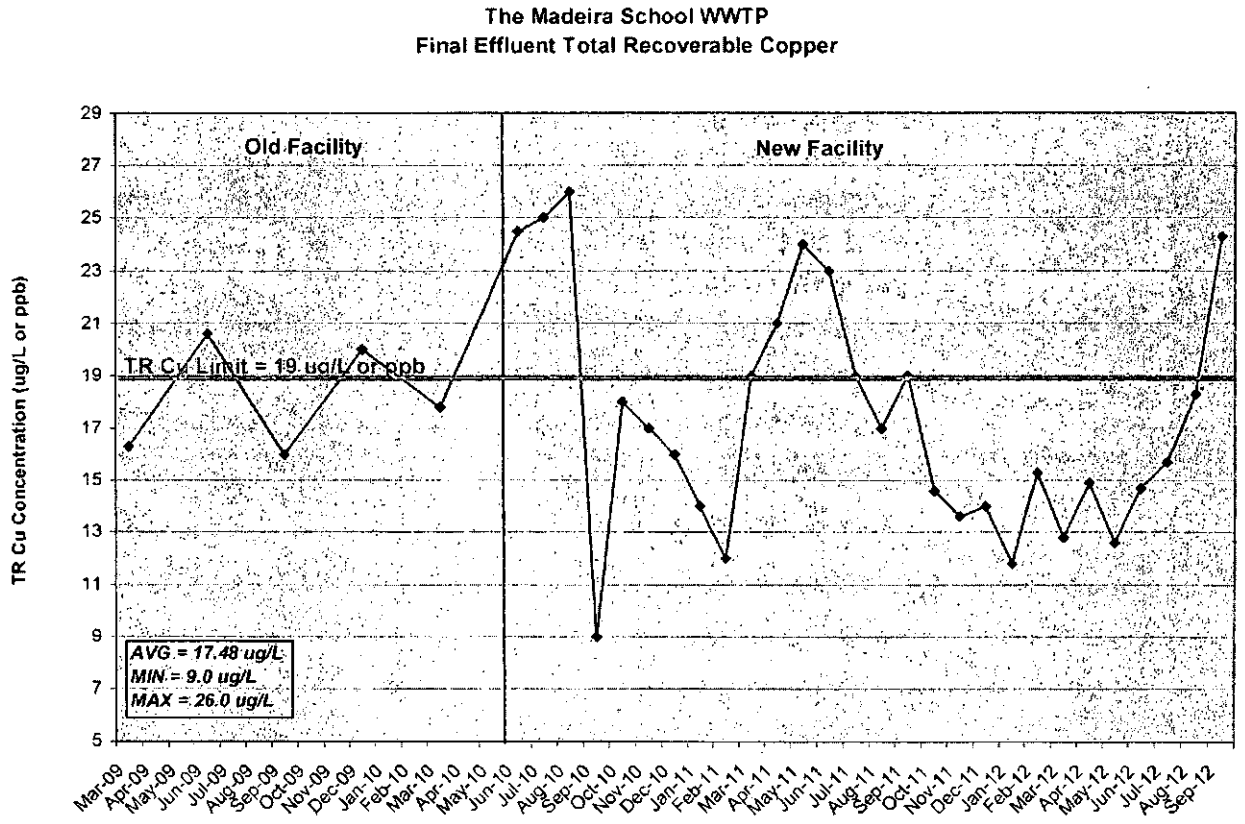
### *INTRODUCTION*

The Madeira School WWTP is located in Fairfax County near McLean, Virginia. A topographic map of the location is showin in Figure 2 on Page 5. The site is bordered by Difficult Run a tributary of the Potomac River to the north, Great Falls National Park to the west, and Route 193/Georgetown Pike to the south. The plant began operation in the 1940's as an advanced form of wastewater treatment of the school's domestic sewage. As wastewater treatment technology improved over the years several additions to the existing plant were made each providing a more advanced level of treatment at the time. Before going out of commission, the former plant consisted of primarily clarification, trickling filtration, and breakpoint chlorination for ammonia removal. In 2010, a new in ground precast concrete activated sludge treatment facility with tertiary treatment and UV disinfection was constructed. After this new facility was brought online around June of 2010 the former treatment facility was demolished, and the surrounding area restored to a natural area of native shrubs and trees as proposed in the facility closure plan.

The current permitted flow of the new system is 0.0395 MGD. The system consists of a duplex lift station and generator (at the site of the former facility), mechanical screening, flow equalization, extended aeration, secondary clarification, tertiary filtration, and ultra-violet disinfection units. A schematic of the treatment flow pattern is shown in ***Appendix 1***. Effluent discharged from the treatment facility enters the unnamed intermittent tributary via outfall 001. This unnamed tributary originates on the school's property and travels several hundred feet downhill before ultimately discharging into Difficult Run, a tributary of the Potomac River. This facility is monitored daily by The Madeira School and ESS operations and maintenance staff in order to maintain compliance with their Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0024121 issued by the Virginia Department of Environmental Quality (DEQ).

Although there was no limit established on the former treatment facility for Total Recoverable Copper (TR Cu), TR Cu was monitored quarterly as required by the VPDES permit. After construction of the new treatment facility was completed the sewer system was changed over to the new treatment facility and began discharging around June of 2010. Shortly after, the former treatment facility was shutdown in accordance with the approved closure plan for the facility. After June 2010 the new facility began monthly monitoring for TR Cu of the final effluent. Additionally, the DEQ established a TR Cu average and maximum limit of 19 ug/L for the final effluent. Historical TR Cu sampling data ranging from 2009 to present at the facility was complied and shown in Figure 1 on Page 3. After review of the data the TR Cu concentration of the final effluent from the facility ranged between 9 ug/L and 26 ug/L over the three year period with an overall average value of 17.48 ug/L. Although the system is able to meet the 19 ug/L semi regularly it is not able to consistently meet this limit. The system underwent an initial evaluation during parts of 2010 and 2011 attempting to reduce the TR Cu via chemical coagulation and precipitation using Aluminum Sulfate. However, results were inconclusive and generally did not show a favorable outcome for reduction of TR Cu. Due to the facility's small size there is little else that can be feasibly performed at the facility in order to consistently achieve the currently proposed TR Cu limit. Therefore other methods for achieving compliance must be explored.

**Figure 1**


The Madeira School WWTP
Final Effluent Total Recoverable Copper
Old Facility
New Facility
TR Cu Limit = 19 ug/L or ppb
AVG = 17.48 ug/L
MIN = 9.0 ug/L
MAX = 26.0 ug/L
TR Cu Concentration (ug/L or ppb)
29
27
25
23
21
19
17
15
13
11
9
7
5
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
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After significant copper monitoring, and review along with correspondence with the DEQ, it has been determined that the treatment facility does not possess the technology to effectively remove metals; therefore, it is very unlikely that consistent compliance can be attained, regardless of any interim treatment measures implemented. The Madeira School has developed, and implemented a compliance strategy which consists of the identification and implementation of site-specific regulatory alternatives for the permitted limit of copper.

With coordination and approval of the Water Effects Ratio (WER) Study Plan from DEQ, The Madeira School elected to conduct the Study in order to determine if an alternative TR Cu limit exists based on actual water quality conditions demonstrated through the scientific process of an approved WER Study. In the event that the WER Study was successful, The Madeira School will request that the DEQ consider allowing an alternative TR Cu limit based on actual water quality conditions present at the facility through this proven streamlined process.

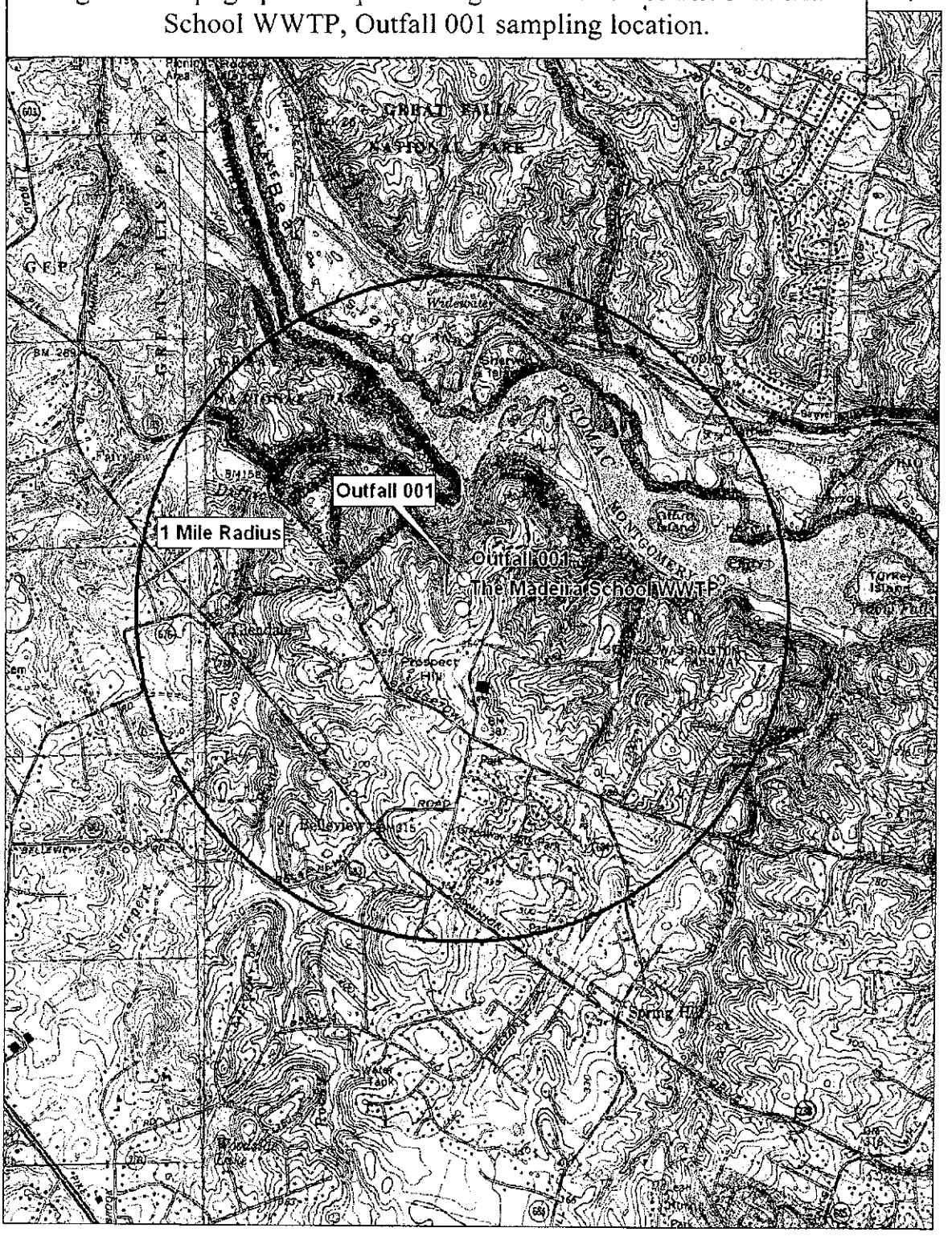
A WER Study is the site-specific regulatory alternative that The Madeira School elected to pursue as part of the planned compliance strategy. Initially, permit limits were established using laboratory generated criteria, which in some cases may not accurately reflect the actual impact of copper toxicity on the receiving stream. In a WER Study site-specific information is generated and used to develop a site specific copper limit based on approval from the regulatory agencies. The following WER Study Plan was proposed and approved by the DEQ on 3/8/12.

*The WER Study shall consist of a minimum of two (2) sampling events at least a month apart during a seasonal low flow event at the receiving stream. The WER will include final effluent monitoring for TR Cu in addition to all other VPDES permit monitoring of the current 0.0395 MGD flow tier, toxicity monitoring, and other various water quality analysis required by the actual WER procedures. Typically, WER Studies combine final effluent and the receiving waters at predetermined ratios based on historical flow data from the receiving water body. The receiving stream in this particular case is a seasonal intermittent tributary of Difficult Run. Although Difficult Run is a larger water body which has substantial flow, the actual wastewater discharge point originates in the unnamed tributary which begins on the property and not in the river. Therefore since no 7Q10 or 1Q10 flow data is available for the unnamed tributary, there will be no mixing zone allowance for the purpose of this WER Study, meaning that the study will be conducted with 100% final effluent from the wastewater treatment plant.*

*The Madeira School will utilize the services of Environmental Systems Service, Ltd. (ESS) for the collection and analysis of effluent samples and final report generation. The Standard Operating Procedures (SOPs) to be used in performing each project task have been provided to The Madeira School and are included as appendices to this document. Please note that these SOPs are proprietary documents and should be treated as such under the Freedom of Information Act.*

The WER Study was conducted on two separate sampling events. The first event occurred on 4/3/12, and the second event occurred on 5/21/12. Sample results from each four hour composite sampling event and their respective WER ratio calculations have been further summarized in Section I.H. on page 13. Appendices 4 and 5 include laboratory support data gathered during each of the collection events.

Figure 2. Topographic Map Showing the Location of The Madeira School WWTP, Outfall 001 sampling location.



# I.

# The Madeira School WWTP

## Copper Water Effect Ratio (WER) Study Protocol

# The Madeira School WWTP
# Copper Water Effect Ratio Study Protocol

This document provides the protocols that were used by The Madeira School to develop a Water Effect Ratio (WER) for copper for use in permitting the discharge from Outfall 001 at The Madeira School Wastewater Treatment Plant. In general, the measures used to develop the WER followed the procedures described in EPA's guidance document *Streamlined Water-Effect Ratio Procedure for Discharges of Copper* (EPA-822-R-01-005 March 2001). Specific protocols used in development of the WER are presented below:

## A. Critical Effluent and Receiving Water Flows

In developing the effluent limit for copper on Outfall 001, DEQ staff used an effluent flow of 0.0395 MGD. There is no 7Q10 or 1Q10 flow data available for the unnamed tributary of Difficult Run therefore it was treated as 0.0 MGD. The copper limit is based on Virginia's acute water quality criterion for the protection of aquatic life.

## B. Collection and Handling of Upstream Water and Effluent

Samples for development of the WER were collected from Outfall 001 during two sampling events spaced approximately seven weeks apart. These events were conducted on 4/3/12 and 5/21/12. Normally WER studies should be conducted during a period of dry weather flow. In this case 100% effluent was used for the Study because the 7Q10 and 1Q10 flows established by the DEQ were zero, therefore no samples from the receiving stream were required to be used to blend to the corresponding ratio.

Samples of the effluent were collected by The Madeira School's contractor ESS using procedures described in ***Appendix 2***. Once collected the samples were immediately preserved between 0 – 6°C in the dark with no air space in the sample container and transported to ESS's contract laboratory Coastal Bioanalysts, Inc. (CBI) in Gloucester, Virginia for toxicity testing. All samples from Outfall 001 were collected via four hour flow proportioned composite method with exception to the Hardness, E. Coli, Dissolved Copper, Dissolved Oxygen (DO), pH, and Total Recoverable Copper which were required to be collected via grab method. Additionally, influent samples were collected during each sampling event via grab. Appropriate chain of custody sample handling procedures were used for all samples and included in Appendix 4.

## C. Laboratory Dilution Water

Laboratory dilution water was synthetic freshwater prepared in accordance with *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, October 2002* (EPA-821-R-02-012). The laboratory dilution water had DOC and TSS concentrations < 5 mg/L, and hardness that was reasonably close to that of the Outfall 001 Effluent samples. The alkalinity and pH of the laboratory water was appropriate for its hardness as given in EPA-821-R-02-012.

## D. Conducting Toxicity Tests

Toxicity tests used for determination of the WER were 48-hour, static, acute tests with *Ceriodaphnia dubia* carried out in accordance with CBI's SOP ETS105G as modified for this project and described in ***Appendix 3.*** CBI's testing protocols are consistent with procedures published in EPA-821-R-02-012 and ASTM E 729-96.

For calculation of the final WER, The Madeira School performed two (2) definitive WER tests using samples collected from Outfall 001 as described in Section B above. In both tests, 100% Effluent was used, which is referred to as "*Site Water*". The toxicity of copper spiked *Site Water* was then compared with the toxicity of copper spiked laboratory water for determination of the WER. Preparation of the *Site Water* test solutions followed the procedure described in E.15.b of Appendix A of EPA-822-R-01-005. Preparation of the laboratory water test solutions followed the procedure described in E.16.b of Appendix A of EPA-822-R-01-005.

Prior to the start of each definitive test, CBI performed 48-hour range finding tests with *Site Water* and *Laboratory Water*. The results of these tests were used to establish the appropriate range of copper concentrations for use in the definitive WER tests.

Detailed procedures for preparation of the *Site Water* and *Laboratory Water* treatments, and for the conduct of the range finding and preliminary and definitive WER tests are described in CBI's Modifications to SOP ETS105 found in ***Appendix 3.*** A general timeline for conducting each definitive WER test is provided in Table 1 on Page 8.

## E. Chemical and Other Measurements

Development of the WER involved numerous analytical measurements for copper and other parameters performed on the *Site Water*, *Laboratory Water*, and toxicity test solutions. A narrative discussion of the analytical testing is provided below.

### 1. Copper

The number and types of planned analyses for copper are shown in Table 2 on page 10. During each of the two WER sampling events, effluent samples were collected by ESS using "clean" sampling procedures as described in ***Appendix 2.*** Aliquots of both samples were analyzed for total and dissolved copper by the contracted lab using EPA Method 200.8.

The remainder of the samples that were analyzed for total recoverable and dissolved copper, using conventional analytical methods, were prepared by CBI in the laboratory prior to and following each WER toxicity test.

**Table 1. Estimated Timeline for Conducting Each WER Test**

| DAY | TIME | RESPONSIBLE | ACTIVITY |
|---|---|---|---|
| 0 | 0900 | ESS | Collect Samples: Effluent, offsite no later than 1100 |
| | 1500 | ESS | Deliver to CBI |
| | 1500-1600 | CBI | • Initial water quality measurements<br>• Prepare unspiked SITE and LAB water and place in sample containers for TOC, TSS<br>• Refrigerate remaining effluent samples |
| | 1600-1700 | CBI | Set up and begin range finding tests with SITE & LAB WATER |
| 1 | 1600-1700 | CBI | 24-hour animal counts and water quality readings range finding tests |
| 2 | 1600-1700 | CBI | End range finding tests<br>• Determine lowest concentrations causing 100% mortality ($C_{RTL}$) |
| 3 | 0800 – 0900 | CBI | Begin warming Effluent |
| | 0900-1000 | CBI | Initiate preparation of SITE WATER serial dilutions:<br>• Prepare spiked Effluent serial dilutions<br>• Let stand 3 hours |
| | 1230-1300 | CBI | |
| | 1300-1330 | CBI | Prepare LAB WATER Treatments:<br>• Allow to stand 1 – 3 hours |
| | 1430-1530 | CBI | Final pretest activities:<br>• 30 mls each treatment removed for initial water chemistry<br>• 25 mls added to 6 test chambers * (7 Concentrations + Control) * 2 (LAB & SITE WATER)<br>• 25 mls added to 2 duplicate test chambers * (7 concentrations + Control) * 2 (LAB & SITE WATER)<br>• 150 ml each treatment (7 concentrations + Control) * 2 (SITE & LAB WATER) added to sample bottles with preservative and stored<br>• 150 ml each treatment (7 concentrations + control) * 2 (SITE & LAB WATER) filtered through 0.45 um filter, filtrate placed into sample bottles with preservative and stored<br>• Prepare equipment blank: 150 ml laboratory water filtered through 0.45 um filter, and filtrate placed into sample bottle containing preservative |
| | 1530 | CBI | TEST START:<br>• Organisms randomly placed into test chambers |
| 4 | 1530 | CBI | 24-hour water quality measurements using first set of chemistry duplicates |
| 5 | 1530-1730 | CBI | TEST END:<br>• Animals counted/observed and findings recorded (LAB & SITE WATER)<br>• Water chemistry measured using second set of chemistry duplicates<br>• Filter through 0.45 um filter all 6 replicates from the following treatments (SITE & LAB water) and place into sample bottles with preservative:<br>o Controls<br>o All concentrations with partial mortalities<br>o The highest concentration with no adverse effects<br>o The lowest concentration with complete mortality<br>• Ship all metals samples T=0 and T=48 copper, and SITE and LAB water TOC, and TSS to ESS Laboratory Services for analyses |

Detailed procedures for the preparation of the samples for copper analyses are described in CBI's Modifications to SOP ETS105 found in ***Appendix 2***. The samples prepared by CBI were transported to the analytical laboratory, where they were analyzed for copper using Inductively Coupled Plasma Mass Spectrometry (ICP MS), EPA Method 200.8. The detection level for copper using ICP MS 200.8 is five (5) ug/L. The detection level of 5 ug/L is believed to be at least three (3) times lower than the copper concentrations that were employed in the WER toxicity testing.

All samples to be analyzed for copper were collected, preserved, and transported in accordance with appropriate Quality Assurance/Quality Control (QA/QC) procedures and in a manner to minimize the potential for contamination.

## 2. Additional Analyses

Analyses that were performed for the WER study are presented in Table 2 on page 10. Analytical methods and detection levels that were used with each parameter are presented in Table 3 on page 11. These analyses were performed for one of the following reasons:

- They are required by the toxicity testing guidelines
- They are recommended by EPA guidelines for conducting a WER study
- They are parameters routinely measured and reported on the DMRs

***Parameters Required by Toxicity Testing Guidelines or Recommended by WER Guidance.***

Water quality parameters required by the toxicity testing guidelines are routinely monitored by CBI during toxicity tests, and are discussed in CBI's SOP ETS105G and modifications to SOP ETS105 described in ***Appendix 3***. In addition, EPA's WER Guidance (EPA-822-R-01-005) recommends that hardness, pH, alkalinity, TOC, TSS, and DOC be measured in the "Site Water" and/or laboratory dilution water. Chemistry "Controls" (or dummy replicates) were used to obtain the required measurements in toxicity test solutions at 24-hours and 48-hours in order to avoid contamination.

***DMR Parameters***

In addition to the total copper analyses described in E.1 above, the following DMR parameters were analyzed at Outfall 001 during each sampling event: Flow, temperature, dissolved oxygen (DO), pH, biological oxygen demand (BOD), total suspended solids (TSS), E. Coli, and ammonia. All effluent monitoring conducted for the months of April and May of 2012 including the WER study sampling events were in full compliance with the VDPES permit.

***Influent Parameters***

In addition to the above analysis, influent grab wastewater samples were collected during each sampling event and analyzed for BOD, TSS, ammonia, and oil & grease – hexane extractable material (O&G-HEM). Of these analyses only Influent O&G-HEM is required to be monitored per the VPDES permit and reported on the DMR.

**THE MADEIRA SCHOOL WWTP**
**WER Study 2012 Table 2**

| | Sample Date | | 4/3/2012 | 4/15/2012 | 5/21/2012 | 5/23/2012 |
|---|---|---|---|---|---|---|
| | Parameters | Units | Results | Results | Results | Results |
| OUTFALL 001 FINAL EFFLUENT | Flow | MGD | 0.0191 | | 0.0293 | |
| | E.Coli | MPN/100 mL | <1 | | 1.0 | |
| | TSS | mg/L | <1 | | 1.50 | |
| | TOC | mg/L | 7.22 | | 7.55 | |
| | DOC | mg/L | 4.5 | | 6.64 | |
| | BOD | mg/L | <2 | | <2 | |
| | Hardness | mg/L | 140 | | 146 | |
| | Alkalinity | mg/L | 147 | | 173 | |
| | Diss. Copper | mg/L | 0.0153 | | 0.0130 | |
| | Total Copper | mg/L | 0.0149 | | 0.0126 | |
| | NH3 | mg/L | <0.10 | | <0.10 | |
| | pH | S.U. | 7.66 | | 7.89 | |
| | DO | mg/L | 11.10 | | 8.91 | |
| | Conductivity | umhos/cm | 866.00 | | 870.00 | |
| | Temperature | ° C | 14.1 | | 20.5 | |
| INFLUENT | BOD | mg/L | 154 | | 212 | |
| | TSS | mg/L | 113 | | 92.1 | |
| | NH3 | mg/L | 26.6 | | 21.4 | |
| | O&G-HEM | mg/L | <5.00 | | 10.2 | |
| WER/OUTFALL 001 | TSS (LAB) | mg/L | | <1 | | <1 |
| | TSS (SITE) | mg/L | | <1 | | <1 |
| | Total Copper (Lab Control) | mg/L | | <0.00500 | | <0.00500 |
| | Total Copper (5.88) Lab | mg/L | | 0.0056 | | 0.00617 |
| | Total Copper (8.40) Lab | mg/L | | 0.00748 | | 0.00762 |
| | Total Copper (12.0) Lab | mg/L | | 0.0104 | | 0.0104 |
| | Total Copper (17.2) Lab | mg/L | | 0.0148 | | 0.0139 |
| | Total Copper (24.5) Lab | mg/L | | 0.0194 | | 0.0192 |
| | Total Copper (35.0) Lab | mg/L | | 0.0290 | | 0.273 |
| | Total Copper (50.0) Lab | mg/L | | 0.0403 | | 0.0388 |
| | Total Copper (Site/Eff Control) | mg/L | | 0.0148 | | 0.0137 |
| | Total Copper (58.8) Site/Eff | mg/L | | 0.0652 | | 0.0604 |
| | Total Copper (84.0) Site/Eff | mg/L | | 0.0846 | | 0.0837 |
| | Total Copper (120) Site/Eff | mg/L | | 0.123 | | 0.112 |
| | Total Copper (172) Site/Eff | mg/L | | 0.166 | | 0.147 |
| | Total Copper (245) Site/Eff | mg/L | | 0.236 | | 0.206 |
| | Total Copper (350) Site/Eff | mg/L | | 0.313 | | 0.270 |
| | Total Copper (500) Site/Eff | mg/L | | 0.486 | | 0.406 |
| | DOC (LAB) | mg/L | | <1 | | <1 |
| | DOC (SITE) | mg/L | | 4.64 | | 6.28 |
| | WER | n/a | **6.921** | | **5.192** | |

| | | |
|---|---|---|
| **FINAL WER (Calculated Geometric Mean of Ratios)** | **5.994** | |
| **FINAL WER (Maximum Allowable WER From EPA)** | **5.000** | |
| **Current VPDES Permit Limit for Total Recoverable Copper** | **19** | **ug/L** |
| **Proposed VPDES Permit Limit for TR Copper Based On WER Study** | **95.00** | **ug/L** |

## Table 3. Analytical Methods and Detection Levels for use in WER Study

| Parameter | Analytical Method | LOD | LOQ | Units |
|---|---|---|---|---|
| Alkalinity | SM 2320 B | 1 | 2 | PPM |
| Ammonia | SM 4500 NH3 D | | 0.1 | PPM |
| Biochemical Oxygen Demand | SM 5210 B | | 2 | PPM |
| Conductivity | SM 2510 | | 1 | PPM |
| Dissolved Copper | EPA Method 200.8 | 0.001 | 0.005 | PPM |
| Dissolved Organic Carbon | SM 5310 C | | 1 | PPM |
| Dissolved Oxygen | SM 4500 OG | 0.1 | | PPM |
| E. Coli | SM 9223 B | | 2 | MPN |
| Hardness | SM 2340C | 1 | 2 | PPM |
| pH | SM 4500-H+ B | | | SU |
| Total Organic Carbon | SM 5310 C | 0.2 | 1 | PPM |
| Total Recoverable Copper | EPA Method 200.8 | 0.002 | 0.005 | PPM |
| Total Suspended Solids | SM 2540D | | 1 | PPM |

## F. Calculation of the Water Effects Ratio and Site-Specific Criteria

The acceptability of each toxicity test will be evaluated individually. Tests with substantial deviations from the laboratory practices presented in the EPA WER guidance and/or EPA, ASTM, and CBI protocols for conduct of the tests will be rejected.

The $LC_{50}$s for laboratory and site water tests were calculated using dissolved (mean) and total copper concentrations. The method employed for calculation of the $LC_{50}$ was appropriate for the data, and the same computational methods (e.g., Probit, computational interpolation, etc.) were employed for both tests from a particular sampling event. Guidelines for calculation of laboratory and "Site Water" EC50s presented in Appendix A, Section G.3 and G.4 of EPA's Streamlined WER Guidance will be followed for calculation of the LC50s in laboratory and site water, respectively.

The $LC_{50}$s determined for the laboratory water, "Site Water", and the Species Mean Acute Value (SMAV) for C. dubia were normalized to the same hardness. The sample WER was determined for each pair of hardness-normalized $LC_{50}$ values as follows:

$$\frac{LC_{50}\text{ (site water)}}{LC_{50}\text{ (laboratory water)*}}$$

*If the hardness-normalized laboratory water LC50 is less then the hardness-normalized SMAV value for *C. dubia*, then the hardness-normalized SMAV value will be used.

The site WER will be calculated as the geometric mean of the two (or more) sample WERs. Site-specific dissolved copper criteria will then be calculated as Virginia's default dissolved copper criteria multiplied by the WER.

## G. REPORTING

Following completion of the WER study The Madeira School results were reviewed and the WER calculated. A final report has been developed and provided to the DEQ including the following:

- Summary of the sampling and analytical procedures employed
- Summary of the analytical results
- Summary of QA/QC results, addressing data validation
- Discussion of the calculations used to derive the WER
- The final copper WER

## H. INTERPRETATION OF WER RESULTS

Of the WER Study collection event that occurred on 4/3/12, "Site Water" yielded a WER of 11.96 for site water EC50 divided by lab water EC50, and a ratio of 6.921 for the site water divided by the Species Mean Acute Value from Appendix B of EPA Streamlined WER Procedures for Discharges of Copper. The lower of the two ratios was used in the calculation of the final ratio (geometric mean of both sampling events) as shown in Table 4 below.

Of the WER Study collection event that occurred on 5/21/12, "Site Water" yielded a WER of 8.574 for site EC50 divided by lab water EC50, and a ratio of 5.192 for site water divided by the Species Mean Acute Value from Appendix B of EPA Streamlined WER Procedures for Discharges of Copper. The lower of the two ratios was used in the calculation of the final ratio (geometric mean of both sampling events) as shown in Table 4 below.

**Table 4**

***Study 1***

| Test Matrix | 48HR EC50 (ug/L) | 95% C.L. | Test Hardness (mg/L CaCO3) | Normalized 48HR EC50 (ug/L) |
|---|---|---|---|---|
| Lab Water | 18.82 | 17.72 - 20.00 | 138 | 18.82 |
| Site Water | 225.0 | 210.8 - 240.1 | 138 | 225.0 |
| **Chemical Basis** | **WER Denominator** | **Normalized Site Water EC50 (ug/L)** | **Normalized Lab or SMAV EC50 (ug/L)** | **WER** |
| Total Copper | Lab Water | 225.0 | 18.82 | 11.96 |
| Total Copper | EPA 2001 | 225.0 | 32.51 | ***6.921*** |

***Study 2***

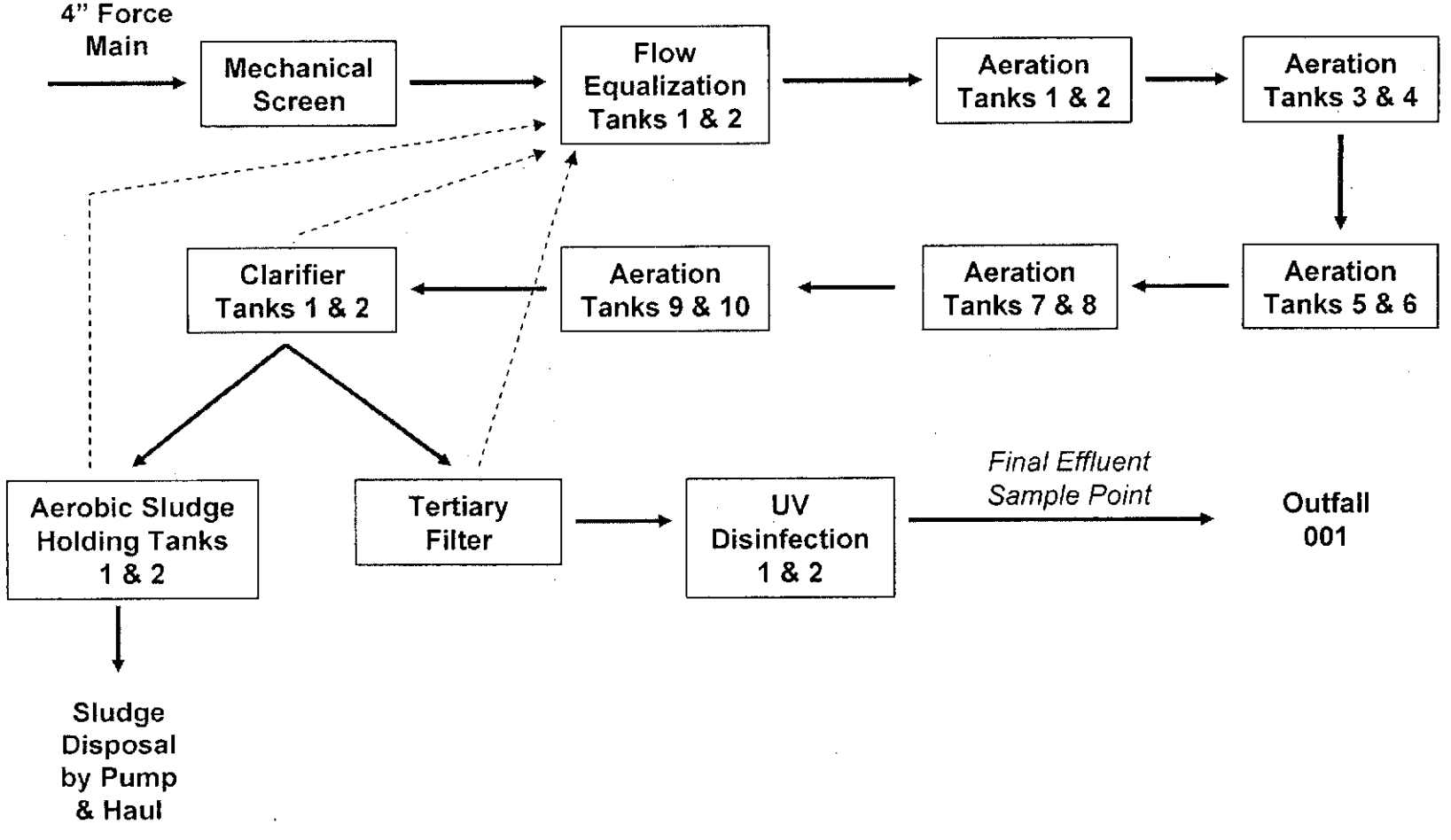
| Test Matrix | 48HR EC50 (ug/L) | 95% C.L. | Test Hardness (mg/L CaCO3) | Normalized 48HR EC50 (ug/L) |
|---|---|---|---|---|
| Lab Water | 20.07 | 18.52 - 21.75 | 144 | 20.07 |
| Site Water | 170.5 | 158.3 - 183.6 | 140 | 175.7 |
| **Chemical Basis** | **WER Denominator** | **Normalized Site Water EC50 (ug/L)** | **Normalized Lab or SMAV EC50 (ug/L)** | **WER** |
| Total Copper | Lab Water | 175.7 | 20.07 | 8.754 |
| Total Copper | EPA 2001 | 175.7 | 33.84 | ***5.192*** |

| | |
|---|---|
| **Final WER** | **5.994** |
| **Maximum Allowable WER (EPA)** | **5.000** |
| **VPDES Copper Limit** | **19** |
| **Proposed VPDES Copper Limit with WER Applied** | **95** |

In summary, the WER for The Madeira School WWTP has been calculated by using the geometric mean of the lowest ratios determined from the 4/3/12 and 5/21/12 sampling events, which had ratios of 6.921 and 5.192 respectively. The geometric mean of these two ratios was calculated as 5.994, however the maximum allowable ratio by EPA is 5.000. Therefore applying the WER of 5.000 to the current permitted limit for Total Recoverable Copper of 19 ug/L yields a concentration of 95 ug/L. The Madeira School requests that the DEQ consider the conclusions of this WER Study when developing a VPDES Total Recoverable Copper Limit for the facility.

# APPENDIX 1

# Flow Process Diagram of The Madeira School WWTP



# APPENDIX 2

# Protocol for Collection and Handling of Water Samples for use in The Madeira School WWTP Water Effect Ratio (WER)

## General Guidelines

Preliminary Considerations

1. All sample equipment will be cleaned and preserved by one of the following labs;
   - Environmental System Services
   - Coastal Bioanalysts
2. ESS will collect a monthly Hardness at the final effluent sampling point for Outfall 001 until study has been completed.
3. ESS will provide analytical services for the Hardness and all other samples collected for TOC, and TSS.
4. DMR Reporting- All DMR required parameters measured in the field will be reported to ESS staff responsible for DMR completion in time to complete the DMR by the 10th of the month following collection.

Sampling Plan

1. ESS will perform two (2) sampling events to collect the WER samples.
2. Each WER sample will be collected with a peristaltic pump, using new vinyl tubing. Tubing will be flushed with approximately 1 gallon of wastewater prior to collection of samples.
3. Five (5) gallons will be collected in a new cubitainer filled to the top of the container, properly packaged in a cooler and preserved on ice. Cubitainers will be rinsed with sample prior to filling. The properly preserved and packaged carboy will be transported and relinquished to Coastal Bioanalyst Inc. (CBI), while maintaining the sample chain of custody.
4. ESS will collect the sample early during the day to allow the ESS technician to deliver the sample to CBI by 1500, the day of collection.

## Water Effects Ratio Sampling Procedures

1. ESS arrive onsite.
2. ESS technicians set up peristaltic pump at sampling location Outfall 001.
3. At outfall 001 pH, Dissolved Oxygen, Conductivity, Flow, and Temperature measurements will be taken by an ESS technician. Of these parameters pH, Dissolved Oxygen, Flow, and Temperature are to be reported on the DMR.
4. Samples for TOC, TSS, Hardness, Alkalinity, DOC, Total Copper, Dissolved Copper, BOD, E. Coli, and, TKN will be collected at outfall 001 in bottles provided by the analytical lab. Of these parameters BOD, TSS, E. Coli, and TKN are to be reported on the DMR.
5. The technician will collect five (5) gallons of sample in a new cubitainer. This container will be preserved on ice in a cooler, then immediately transported to CBI.



ESS

# APPENDIX 3

# *Ceriodaphnia dubia* ACUTE TEST

**EPA 2002.0**





APPROVED: Peter F. De Lisle, Ph.D., Technical Director 5/9/07



**Distribution:**

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*Methods must be reviewed at least annually by the quality assurance officer as part of the annual audit and managerial review. All affected staff reading a method for the first time should certify such in their personnel file.

**TEST METHOD**

EPA 2002.0

**APPLICABLE MATRICES**

Aqueous. This species cannot tolerate highly saline matrices (NaCl NOEC is 1 g/l, LOEC 2 g/l).

**DETECTION LIMIT**

Not applicable to toxicity.

**SCOPE AND APPLICATION**

1. This test method measures the acute toxicity (LC50) of effluents to the freshwater cladoceran, *Ceriodaphnia dubia*, during 24-h to 48-h static or 48-h to 96-h static-renewal exposures. The method may also be used for determining the NOAEC without any modification of test design.
2. This test is used as a definitive test consisting of five effluent concentrations and a control. Other designs, such as testing 100% sample from each of several stations plus a control and/or reference site may be used for testing surface waters, elutriates, etc.
3. This version of this SOP incorporates NELAP-required elements; the actual conduct of the test method is unchanged from the previous version of the SOP (ETS105E, 2/18/03).

**SUMMARY OF TEST METHOD**

1. Daphnids (< 24-h old) are exposed to five different concentrations of an effluent during the 24-h or 48-h test. Pass/fail NOAEC tests use only a control and critical (e.g. 100%) effluent concentration. Multi-dilutional NOAEC tests are also often specified in permits.
2. Water quality is monitored daily. Tests may be static or static renewal and may be extended to 96 h duration with feeding and daily renewal or renewal at 48 h.
3. The number of live daphnids is also recorded daily. The test endpoint is survival.
4. Valid tests must have a minimum of 90% control survival. Refer to references below for additional information.

**DEFINITIONS**

Unless otherwise specified, the term effluent is used, for the sake of convenience, throughout this document to refer to effluents, ground waters, receiving waters, leachates, elutriates and other aqueous samples. See also DRS801 for additional definitions and terms.

**INTERFERENCES**

1. Excessive headspace or insufficient chilling of samples during shipment and storage may result in toxicity being underestimated.
2. Improper handling may adversely affect both organism and sample condition.
3. Indigenous organisms which may be predators or pathogens of the test organisms, or are similar in appearance to the test organisms, may confound toxicity test results.
4. pH drift during testing may result in artifactual toxicity of pH-dependent toxicant (e.g. metals, ammonia). See SOP ETS204 for pH control methods. Note: <u>If results are to be used for compliance purposes modifications for pH control require approval of the regulatory authority before implementation.</u>

## SAFETY, WASTE MANAGEMENT AND POLLUTION PREVENTION

1. Collection and use of effluents in toxicity tests may pose risks to personal safety and health. Standard laboratory safety procedures must be adhered to at all times. Gloves must be worn at all times when handling samples.
2. Effluents discharged under NPDES permits may be poured directly down the drain. Except for pH adjustment (> 5), all reagents used in this test and supporting analyses (e.g. ammonia, alkalinity, etc.) do not require any pre-treatment prior to discharge to the sanitary sewer.

## EQUIPMENT AND SUPPLIES

1. Daphnids (< 24-h old), minimum of 150 (120 for test, 30 for "surrogate" chambers used for water quality measurements on day 1). Suppliers of brood stock (in order of preference):
    a. Chesapeake Cultures (Elizabeth Wilkins 804-693-4046)
    b. Aquatic BioSystems (Scott Kellman 800-331-5916)
    c. Aquatic Research Organisms (800-927-1650)
2. YCT/*Selenastrum*
3. Temperature controlled (20 or 25 $\pm$ 1 °C) lab
4. Light table
5. Calibrated thermometers
6. Test chambers, (30) 30-ml portion cups, scintillation vials, or equivalent; all identical
7. HDPE Template (Fig. 1)
8. Funnel, with 60 um mesh
9. Calibrated flasks, 250-ml
10. Wash bottles containing DI H2O
11. Graduated cylinders 100-ml
12. Pipettes, pipette pumps and pipette bulbs
13. Tape, markers
14. Data sheets
15. Air lines, Pasteur pipettes and air stones

## REAGENTS AND STANDARDS

1. DI H2O (ASTM Type I)
2. Moderately hard standard synthetic freshwater
3. KCl Sigma Ultra grade

## SAMPLE COLLECTION, SHIPMENT, STORAGE AND PREPARATION

Refer to SOP ETS201 regarding sample collection and shipment; this is usually the responsibility of the client or a subcontractor.

Samples must be properly stored and prepped prior to use in toxicity tests. Incorrect sample storage or prep may invalidate the test and/or affect test results. Refer to SOP SPLS202 and ETS203 for sample receipt and prep procedures.

**REQUIRED TEST CONDITIONS**

| | |
|---|---|
| TEST TYPE: | Static (24-h or 48-h), 48-h static-renewal, or 96-h static renewal (daily or at 48h). Permit specific. (Codes - Static: ACD Renewal: ACD – 48R, -96DR, -96R1) |
| TEST CONCENTRATIONS (%): | Depends upon WET limit or other permit limit. Permit may specify a dilution series. Dilution factor for effluents is ≥ 0.5X unless otherwise specified by regulatory authority or special test objectives. Typical: 100, 50, 25, 12.5, 6.25%. May also be NOAEC pass-fail test. |
| DURATION: | 24 or 48 ± 0.5 h; 96 ± 0.5 h with renewal daily or at 48-h |
| REPLICATES: | 4 with 5 animals each (i.e. 20 animals/concentration; LC50 & NOAEC tests) |
| RANDOMIZATION: | Test chambers oriented in randomized block design (DRS601) |
| TEST CHAMBERS: | Borosilicate glass scintillation vials, portion cups or equivalent |
| TEST VOLUME: | 15 ml |
| TEMPERATURE: | 25 ± 1° C or 20 ± 1° C (max-min 3° C maximum) (permit specific) |
| DILUTION WATER: | Standard synthetic freshwater (SFW), moderately hard[1] |
| PHOTOPERIOD: | 16 h light/8 h darkness |
| LIGHT INTENSITY: | 10-20 uE/$m^2$/s (50-100 ft-c) (ambient laboratory illumination) |
| AGE: | < 24-h old |
| D.O.: | ≥4.0 mg/l, do not aerate test chambers |
| FEEDING: | Feed YCT/*Selenastrum* while holding (min. 2 hr) prior to test; not fed during 48-h test. For 96-h test feed 0.2 ml YCT/*Selenastrum* mixture/beaker 2 h prior to renewal at 48 h |
| CLEANING: | Not required. New (clean) chambers used for renewals. |
| SAMPLE HOLDING TIME: | 36 h first use, may be used for renewal for up to 72 h after first use |
| TEST ACCEPTABILITY: | ≥ 90% control survival; test must not be prematurely terminated |

[1] Dilution water may be of same hardness as the receiving water if known and approved by the regulatory authority. In some cases the receiving water may be used as the diluent (permit specific). Both a site-hardness SFW or receiving water control and a standard synthetic water control must be run.

**IMPORTANT NOTES:**

**Recording data:**

1. Use only permanent ink, waterproof pen for all logbook and bench sheet entries.
2. Fill in information requested on bench sheets completely, on a real-time basis.
3. Write neatly and legibly.
4. Corrections to bench sheet entries must be performed by placing a single line through the incorrect entry, writing the corrected entry as near its appropriate space as possible and initialing the correction. Write an explanation of the error if needed (footnote with number if necessary due to space limitations).

**Control of contamination:**

Samples may contain bacteria or fungi which are pathogenic to test organisms, especially fathead minnows. To decrease the possibility of control or between-test pathogen or toxicant contamination:

1. Gloves must be worn whenever hands come in contact with effluent, dilution water, test vessels, etc.
2. Use a dedicated pipette for transferring animals for each test and for controls (Renewal tests).
3. Obtain Day 0 water quality measurements by pouring water from beakers used for sample prep into dedicated 30-ml beakers. Collect final water quality measurements from surrogate beakers (see Fig. 1) on Day 1 and from test beakers on Day 2 (test termination). Be careful not to splash or aerate sample during collection of aliquots.
4. Change pH probe soak daily, using a new container.

**PROCEDURE & METHOD PERFORMANCE**

Refer to the work order database to determine client (permit) specific test requirements such as dilution series, duration, dilution water, species and dechlorination and pH adjustment procedures. See SOP ETS203 for guidance on preparing dilutions.

**Test Set Up** (Day 0)

1. The test should be set up as soon as practical within sample holding time (36 h).
2. Test animals must all be from the same source and must have exhibited acceptable survival ($\geq$ 90%) during the previous 24-h period. Unacceptable survival can be identified by examining the brood board for dead adults among the group(s) of organisms being used for production of test neonates (e.g. 6-day and 7-day olds).
3. Collecting test organisms:
    a. Record vials with offspring on brood board and time checked periodically during the afternoon, night and/or morning before the test is set up so that a sufficient number of animals can be collected which are all released within the 24-h period prior to the start of the test (see CULS002).
    b. Select daphnids for test of appropriate age (<24 h at test set up) from animals with good brood sizes ( >10) which have produced a minimum of 3 broods. Only select animals which appear to be in good health, i.e. swimming, good color, size and shape.
    c. Pool animals in a bowl, feed YCT + *Selenastrum* mixture (ca. 2 ml/150 ml) and place bowl in test lab at least 2 hr. prior to test start up.
4. Select and label a template board (Fig. 1). Record brood release data (i.e. age), acclimation temperature, template number, etc. on bench sheet.
5. Prepare effluent sample, approximately 200 ml for a single Ceriodaphnia, more if additional species are to be tested (exact amount will also depend on the dilution series used; 200 ml based on 0.5 x dilution series). Record sample pH, temperature, conductivity and D.O. Note: Sample pH should be 6.0-9.0; if not, additional treatments may need to be set up. See Sample Preparation SOP ETS203 for detailed instructions.
6. Check dilution water to ensure acceptable temperature, conductivity, pH and D.O. and record measurements. Check that hardness and alkalinity measurements for the batch of dilution water are within specifications (SOP

RWS001) and transcribe values and vat number from the batch sheet to the effluent/dilution water prep sheet for the test. Note: SFW diluent should not be used for more than two weeks. Note: If animals are cultured in a water different than that used for the test dilution water then a second control (culture water control) must be tested.

7. Because of the small volumes of water (15 ml) used, the test chambers must be thermally equilibrated to the test temperature prior to use.
8. Pour the control (dilution water only), using a separate, labeled and calibrated 250-ml flask. Fill to the 100 ml mark. Pour approximately 15 ml into each of 5 test chambers, placing on appropriate block on template. The fifth replicate is placed in the 5th row of the template (Fig. 1); this chamber will receive the requisite number of test organisms (5) but will be sacrificed on day 1 for water quality measurements (i.e. these animals are not counted for LC50 determination). These "surrogate chambers" are used to prevent contamination from probes and damage to animals.
9. Pour excess (~25 ml) into a 30-ml beaker for initial (day 0) water quality measurements. Make sure the 30-ml beakers are clean, dry and equilibrated to test temperature before use.
10. Pour the remainder of the test by measuring out the amount of effluent needed (using graduated cylinder or pipette as appropriate) into a labeled, pre-calibrated 250-ml flask and diluting to 100 ml calibration mark with SFW. Alternatively, serially dilute 200 ml by pouring off 100 ml portions working in order of decreasing concentrations, Mix, pour into test chambers (excess into 30 ml beakers) and place chambers in appropriate wells on template as described above. Record time test poured.
11. Immediately after pouring test solutions measure (in 30-ml beakers) and record, in order of increasing concentration:
    a. Temperature, pH, conductivity and D.O. in one replicate of each concentration.
    b. Total residual chlorine (TRC) in the highest concentration if present at sample check-in (also in dilution water if chlorine may be present; e.g. if a receiving water is used as diluent); record on effluent prep sheet.
    c. Check that values make sense with respect to required test conditions, internal consistency and saturation values. Unusual values may indicate instrument drift since last calibration, measurement error, etc.
12. Transfer neonate daphnids, using a disposable pipette (watch daphnid exit pipette tip under water surface), one or two at a time, until there are 5 in each chamber. Only select animals which appear to be in good health, i.e. swimming, good color, size and shape; avoid undersize animals. Because the chambers are in random order and only one or two animals are placed in each chamber per time, this method insures healthy animals are randomly assigned to treatments. Verify that the correct number of animals are added to each chamber. Record time the daphnids are added, this is the time the test started. Animals should be added as soon as possible and no more than one hour from the time the test was poured.
13. Loosely cover chambers.
14. Check survival in the highest concentration approximately 1 h after test is set up. If mortality is observed at that time additional, lower, test concentrations may have to be set up (e.g. 3.13 and 1.56%). The number of additional concentrations should be based on the extent of mortality observed in lower test concentrations.
15. Rinse 30 ml beakers well with deionized water and invert to dry (in test lab to insure thermal equilibration) for use the next day.
16. Prepare dilution water as needed to be used the following day (Renewal tests)

**Daily Tasks** (Day 1 (or 2 and 3))

Static Tests:

1. Measure and record, in order of increasing concentration, temperature, pH, and D.O. in the fifth (surrogate) replicate of each concentration. Discard solution after measurement. Check that values make sense with respect to previous day's values, concentrations, saturation values, required conditions, etc. Unusual values may indicate instrument drift since last calibration, measurement error, etc.

2. Count and record the number of live daphnids. Record time, and initials. Remove any dead animals. NOTE: Although dead bodies may sometimes dissolve they usually don't. Verify live count + dead count = previous day total.

Static-Renewal Tests: (Note: If a 96-h test feed 0.2 ml YCT/*Selenastrum* concentrate/chamber 2 h before renewal at 48 h)

1. Prepare effluent sample as above.
2. Check dilution water to ensure acceptable temperature, conductivity, pH and D.O. and record measurements. Check that hardness and alkalinity measurements for the batch of dilution water are within specifications (SOP RWS001) and transcribe values and vat number from the batch sheet to the effluent/dilution water prep sheet for the test.
3. Prepare each concentration separately, pour into a new set of test chambers (see sect. 8-10 above).
4. Collect "initial" (after renewal; on aliquots from prep flasks) measurements for each concentration.:
    a. Temperature, pH, conductivity and D.O. in one replicate of each concentration.
    b. Total residual chlorine (TRC) in the highest concentration and control if present at test initiation
    c. Check that values make sense with respect to required test conditions, internal consistency and saturation values. Unusual values may indicate instrument drift since last calibration, measurement error, etc.
5. Count the number of survivors as daphnids are transferred (watch daphnids exit pipette tip, placed under water surface) into new solutions; verify (recount) after transfer. Place the chamber with daphnid and fresh solution back on the test board in the correct well. Be careful not to slosh water, causing the daphnids to stick to the wall of the vessel. Record time of transfer, number of survivors and initials.
6. Measure and record in old solutions "final" (before renewal) water quality parameters:
    a. Temperature, pH, and D.O. in one replicate of each concentration.
    b. Total residual chlorine (TRC) in the highest concentration* and control if present at test initiation
    c. Check that values make sense with respect to required test conditions, internal consistency and saturation values. Unusual values may indicate instrument drift since last calibration, measurement error, etc.

*Highest test concentration with surviving animals in the period 24 h prior to measurement.

**Termination of Test** (48±0.5 h or 96±0.5 h)

1. Count and record the number of live daphnids. Record time and initials. NOTE: Although dead bodies may sometimes dissolve they usually don't. Verify live count + dead count = previous day total.
2. Measure and record, before renewal, in order of increasing concentration:
    a. Temperature, pH and D.O. in one replicate of each concentration.
    b. Conductivity in the highest concentration and control.
    c. Total residual chlorine (TRC) in the highest concentration and control if present at test initiation
    d. Check that values make sense with respect to required test conditions, internal consistency and saturation values. Unusual values may indicate instrument drift since last calibration, measurement error, etc.
3. Remove all test glassware to wash area. Discard any remaining sample. If sample needs to be saved for later chemical analysis, mark the container (red tape on cap) to indicate it is an archived sample.

## CALCULATIONS AND DATA ANALYSIS

1. For all treatments and controls calculate the percent total survival.
2. The TAC and statistics are determined using performance of animals in the dilution water control; if a culture water or similar control is included its purpose is only to evaluate the appropriateness of the dilution water.
3. Refer to SOPs DRS101 and DRS102 for calculation and data analysis procedures:
    a. For LC50 tests calculate the LC50 using appropriate method (SOP DRS101).

b. For pass-fail NOAEC tests evaluate the critical concentration using hypothesis testing (e.g. Student's t-test; SOP DRS102)
c. For multi-dilutional NOAEC tests evaluate the critical concentration using hypothesis testing and calculate the LC50 if sufficient mortality occurs.

## QUALITY CONTROL/DATA ASSESSMENT & ACCEPTANCE CRITERIA

1. Test acceptability criteria (TAC): Valid tests must have a minimum of 90% control survival. The TAC and statistics are determined using performance of animals in the dilution water control; if a culture water or similar control is included its purpose is only to evaluate the appropriateness of the dilution water. In addition, the test must be conducted in accordance with specified test conditions (temperature, test organism age, etc.; see below). Tests must not be terminated prematurely (i.e. ± 0.5 h).
2. All supporting activities, such as preparation of dilution water, balance use and calibration, etc., must be performed in strict accordance with laboratory SOPs.
3. A test may be deemed conditionally acceptable if there are minor deviations from specified conditions; determination of conditional acceptance based on degree of departure and objectives of test shall be made by the laboratory technical director and/or permitting authority and noted I the final report.
4. Reference toxicant tests must be performed each month the method is performed. If animals are purchased from an outside source a concurrent reference toxicant test must be conducted with the same batch of animals used in the effluent test. These tests are conducted similar to effluent tests except that a standard dilution series is tested using a concocted "100% effluent" composed of the reference toxicant (KCl) and laboratory dilution water (see below).

### Reference Toxicant Test Concentrations/Dilutions:

1. Prepare "100%" concentration by dissolving 572 mg of KCl (Sigma "Ultra" grade, current lot in use) in 500 ml of SFW dilution water. Record KCl "A" number on bench sheet. Use a calibrated flask, initially adding the KCl to ca. 400 ml of dilution water and then bringing to 500 ml volume after complete dissolution of the reference toxicant. Mix well.
2. Test the following concentrations of "100%" reference toxicant sample: 100%, 70%, 49%, 34.3%, 24.0%; i.e. a 0.7X dilution factor. These correspond to 1144, 800, 560, 392 and 275 mg/l KCl.
3. The test must be performed using the same procedures as for a static effluent test.

## OUT-OF-CONTROL/UNACCEPTABLE DATA: CORRECTIVE ACTIONS AND CONTINGENCIES

Immediately notify the QA officer if data are out of control limits or unacceptable.

## CALIBRATION AND STANDARDIZATION

Calibration is not applicable to toxicity testing. See QSS301 and QSS302 for precision estimation and standardization using reference toxicants and PT samples.

## REFERENCES

See Quality Manual

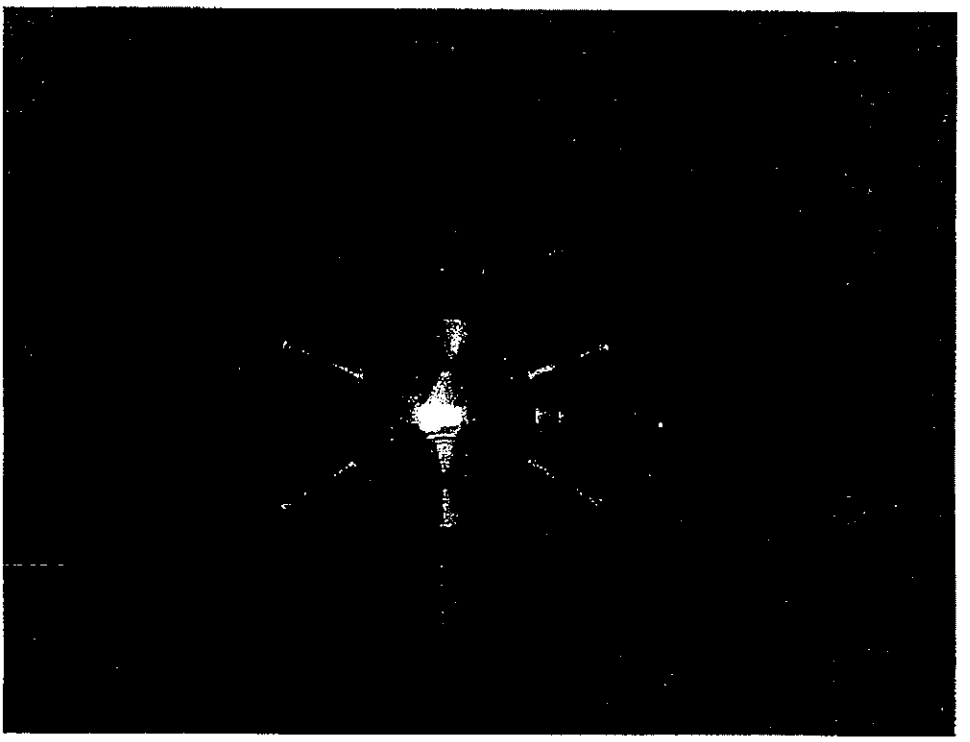

Fig. 1. Acute *Ceriodaphnia* test template. Rear row is for surrogate vessels for Day 1 water quality measurements.

# APPENDIX 4

Client: Environmental Systems Service, LTD.
Project ID: ESSL1205
Client Sample ID: Madiera School Outfall 001
Permit No: VA0024120
Sample Period: 4/3/12

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Coastal Bioanalysts, Inc.

# REPORT: MADIERA SCHOOL - COPPER WER (ROUND 1)

| **Submitted To:** | **Prepared By:** |
|---|---|
| Ms. Angie Woodward<br>Environmental Systems Service, LTD.<br>218 North Main Street, P.O. Box 520<br>Culpeper, VA 22701 | Coastal Bioanalysts, Inc.<br>6400 Enterprise Court<br>Gloucester, VA 23061<br>(804) 694-8285<br>www.coastalbio.com<br>Contact: Peter F. De Lisle, Technical Director |

## METHODS:

Procedures followed the previously submitted and approved study plan. Test methods are summarized below. Details regarding test conduct and data analysis are provided in attached bench sheets and printouts as applicable.

### Test Organisms

Seven days prior to testing *Ceriodaphnia dubia* cultures were started in hard synthetic freshwater (SFW; 100 mg as $CaCO_3$) using neonate cladocerans. This hardness corresponded to the approximate hardness of an effluent sample collected 3/16/12 (106 mg/L) and was within 20 mg/l of a second value (116 mg/L for a 3/27/12 sample) provided the lab the day prior to sample collection. However, because the hardness of the sample received for testing on 4/3/12 was significantly greater (138 mg/l), animals were acclimated to water of 120 mg/l hardness during the two days prior to final testing on 4/5/12. Cultures were fed YCT-*Selenastrum* (@ $3.5E^7$ cells/ml) at a rate of 0.1 ml of each per 15 ml of culture solution. Production and survival of animals raised in the hard water appeared similar to that of standard lab cultures maintained in moderately hard SFW.

Test animals were < 24 h old and selected from females that had produced 3 or more broods with a minimum of 15 offspring produced by the third brood. Animals were not fed during the test but were fed YCT-*Selenastrum* approximately 5 h prior to use in tests.

### Test Solutions

Hard SFW was prepared according to the EPA recipe by dissolving ACS reagent-grade (or better) salts in high purity deionized water followed by aeration for at least 24 h. Deionized water was obtained from a Barnstead Nannopure Research Series system. The following treatment train was used for the feed water provided to the Barnstead system: well water > 10 um particle > softener > 1 um particle > activated carbon > reverse osmosis > mixed bed anion-cation exchange > 1 um particle > Barnstead Nannopure.

Effluent sample was stored at 3-4° C in the dark until used. Sample was maintained in collapsed Cubitainers with minimal headspace. Effluent was warmed to test temperature prior to use. Minimal (2.0-2.5 min) aeration was necessary to reduce oxygen to saturation concentration for range-finding and definitive tests.

Range-finding tests were used to determine appropriate concentrations for use in definitive toxicity tests. For the range-finding tests copper was added directly to site water and then serially diluted to prepare test solutions. "Site water" consisted of 100% undiluted effluent (based on stream and plant permitted design flow). The lab-water test solutions were similarly prepared by serially diluting spiked hard SFW. Copper was added as a 1 µg/µl (1 mg/ml) stock solution prepared by dissolving 67 mg of ACS reagent-grade $CuCl_2 2H_2O$ (99.999+%; Aldrich lot #15726CH) in 25 ml high purity deionized water. The same stock was used for all tests.



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For the definitive site water test, copper was added to the effluent (site water) and allowed to equilibrate for 3 h prior to adding animals. A 2 L volume of the highest concentration of spiked effluent was prepared by adding 1000 µl of copper stock solution. Thus the final concentration was 500 µg/l (assuming no background Cu). Serial dilutions (0.7X) of spiked site water were prepared by pouring off an 600 ml aliquot of the highest concentration and bringing back to volume with un-spiked effluent. The 600 ml aliquots were added to labeled 1 L plastic beakers. The procedure was repeated to prepare seven beakers of solution of decreasing concentration. A control beaker received 600 ml of un-spiked effluent. The beakers were then allowed to stand for 3 h before being used in tests.

For the definitive lab water test 2 L of the highest concentration of hard SFW was prepared by spiking with 100 µl of copper stock solution (final concentration 50 µg/l). Serial dilutions (0.7X) of the spiked lab water were prepared as described above except using hard SFW as the diluent. The lab water solutions were then allowed to stand for 3 h before being used in tests.

**Chemical Analyses**

Samples of hard SFW and effluent were collected at the beginning of the test for TSS and DOC analyses. Samples were stored at 3-4° C in the dark until shipped with copper samples for analyses. Samples (approx. 200 ml) were collected from each treatment at the beginning of the test for total Cu. Total Cu samples were poured directly into sample containers. Copper samples from both the lab and site tests, as well as TOC and DOC samples, were sent to Analytics (Ashland, VA) for analysis. All sampling supplies were provided by the chemistry lab.

Measurements of dissolved oxygen, pH, temperature, conductivity, total residual chlorine, hardness, alkalinity and ammonia were performed using EPA methods. Instruments and titrations were calibrated using standards and/or titrants traceable to NIST where applicable.

**Toxicity Tests**

Toxicity test methods followed EPA Method 2002.0 (Acute *Ceriodaphnia dubia).* Toxicity tests were conducted using 1 oz. plastic shot glasses rather than borosilicate glass to decrease adsorption of Cu to vessel walls. Six replicates of 5 animals and 25 ml of solution were tested. In addition, two dummy replicates (rather than one) were included for water quality measurements (D.O., pH, temperature, conductivity) at T=24 h and T=48 h. These "chemistry controls" were loaded with test animals in the same manner as actual test chambers. Test chambers were arranged in a randomized block design prior to addition of animals and throughout the test.

**Calculations**

Following the EPA WER guidelines (EPA, 1994) four significant figures were retained in all calculations and endpoints to prevent round-off error. EC50s were calculated using the ToxCalc (version 5.0.23) software.

EC50s for lab and site water tests were calculated using nominal and measured total Cu. Because the probit method could not be used for both sets of tests, the Trimmed Spearman-Karber method was used for all computations of measured Cu toxicity.

EC50 values were normalized to a standard (test) hardness of 138 mg/l based on the WER guidance formula (see EPA 2001) Because lab and site water hardness values were identical, the resulting EC50 values are unchanged.

$$EC50_{\text{Standard Hardness}} = EC50_{\text{Test Hardness}} \times (\text{Standard Hardness/Test Hardness})^{0.9422}$$

For WER calculations, the hardness-adjusted Species Mean Acute Value (SMAV) was based on the value calculated at the criteria reference hardness (CRH, 100 mg/l) and published in the WER guidance document (24.0

µg/l total; EPA2001). The following formula (from EPA 2001) was used to normalize the SMAV value to the test standard hardness of 138 mg/l:

$$SMAV_{Test\ Hardness} = SMAV_{CRH\ (100)} \times (Test\ Hardness/100\ mg/l)^{0.9422}$$

**RESULTS:**

Table 1. EC50 values (Total Cu)

| Test Matrix | 48-h EC50 (µg/l) | 95% C.L. | Test Hardness (mg/l $CaCO_3$) | Normalized* 48-h EC50 (µg/l) |
|---|---|---|---|---|
| Lab Water: | 18.82 | 17.72-20.00 | 138 | 18.82 |
| Site Water: | 225.0 | 210.8-240.1 | 138 | 225.0 |

*Normalized to a standard hardness of 138 mg/l (as $CaCO_3$).

Table 2. Calculated WER values.

| Chemical Basis | WER Denominator Basis* | Normalized Site Water EC50 (µg/l) | Normalized Lab or SMAV EC50 (µg/l) | WER |
|---|---|---|---|---|
| Total Copper | Lab Water | 225.0 | 18.82 | 11.96 |
| | EPA 2001 | 225.0 | 32.51 | **6.921** |

*NOTE: EPA (2001) states " If the hardness-normalized EC50 in laboratory water is less than the documented SMAV for the species (i.e. EPA 2001 value), then use the SMAV in place of the laboratory water EC50 in the dominator of the WER"

Table 3. Biological and Chemical Summary Data - Lab Water Test

| Total Cu (µg/l) | | Survival (%) | |
|---|---|---|---|
| Nominal | Measured | 24-h | 48-h |
| 0* | <1 | 100 | 96.7 |
| 5.88 | 5.60 | 100 | 100 |
| 8.40 | 7.48 | 100 | 100 |
| 12.0 | 10.4 | 100 | 100 |
| 17.2 | 14.8 | 100 | 96.7 |
| 24.5 | 19.4 | 100 | 33.3 |
| 35.0 | 29.0 | 16.7 | 0 |
| 50.0 | 40.3 | 0 | 0 |

*Lab Control (hard synthetic freshwater)

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Table 4. Biological and Chemical Summary Data – Site Water Toxicity Tests

| Total Cu (µg/l) | | | Survival (%) | |
|---|---|---|---|---|
| Nominal | Nominal + Background | Measured | 24-h | 48-h |
| 0* | 14.8 | 14.8 | 100 | 100 |
| 58.8 | 73.6 | 65.2 | 100 | 100 |
| 84.0 | 98.8 | 84.6 | 100 | 100 |
| 120 | 134.8 | 123 | 100 | 100 |
| 172 | 186.8 | 166 | 100 | 96.7 |
| 245 | 259.8 | 236 | 100 | 40.0 |
| 350 | 364.8 | 313 | 100 | 3.3 |
| 500 | 514.8 | 486 | 90.0 | 0 |

*Site Control (100% un-spiked effluent)

Table 5. Test Set-up Information

| Test Matrix | Definitive Test Start Date/Time End Date/Time | Organism Source | Brood Release Date/Time | Acclimation Temp. | Acclimation Water | Test Aerated? |
|---|---|---|---|---|---|---|
| Lab Water | 4/5/12 1605<br>4/7/12 1600 | CBI Stock | 4/4/12 1640<br>4/5/12 1300 | 25° C | Hard SFW | No |
| Site Water | 4/5/12 1620<br>4/7/12 1620 | CBI Stock | 4/4/12 1640<br>4/5/12 1300 | 25° C | Hard SFW | No |

Table 6. Lab and Effluent Water Quality Data

| Water Quality Parameter (Units) | Lab Water | Effluent |
|---|---|---|
| Arrival Temperature (°C) | N/A | 1 |
| Use Temperature (°C) | 25 | 25 |
| Conductivity (µS/cm) | 475 | 843 |
| pH (S.U.) | 7.91 | 7.93 |
| Dissolved Oxygen (mg/l) | 8.2 | 8.2 |
| Total Hardness (mg/l as $CaCO_3$) | 138 | 138 |
| Alkalinity (mg/l as $CaCO_3$) | 147 | 76 |
| DOC (mg/l) | <1.0 | 4.64 |
| TSS (mg/l) | <1.0 | <1.0 |
| Total Residual Chlorine (mg/l) | N/A | <Q.L. |
| Ammonia (mg/l $NH_3$-N) | <1.0 | <1.0 |



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Table 7. Sample Aging/Use/Pretreatment

| CBI Sample I.D. | Collection Date/Time | Date(s)/Time(s) Used in Range Tests | Date(s)/Time(s) Used in Definitive Tests | Sample Adjustments |
|---|---|---|---|---|
| ESSL1205-A | 4/3/12 1105 | 4/3/12 1645-1710 | 4/5/12 1605 (lab), 1620 (site) | Aerated 2-2.5 min |

Table 8. Lab Water Test - Water Quality (Mean/Std. Dev.)

| Nominal Cu (µg/l): | Cont. | 5.88 | 8.40 | 12.0 | 17.2 | 24.5 | 35.0 | 50.0 |
|---|---|---|---|---|---|---|---|---|
| Temp. (°C) | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 |
| D.O. (mg/l) | 8.1<br>0.1 | 8.1<br>0.1 | 8.2<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.2<br>0 |
| PH (S.U.) | 7.94<br>0.08 | 7.96<br>0.07 | 7.98<br>0.04 | 7.99<br>0.03 | 8.00<br>0.03 | 8.01<br>0.02 | 8.01<br>0.02 | 8.00<br>0.04 |

Table 9. Site Water Test - Water Quality (Mean/Std. Dev.)

| Nominal Cu (µg/l): | Cont. | 58.8 | 84.0 | 120 | 172 | 245 | 350 | 500 |
|---|---|---|---|---|---|---|---|---|
| Temp. (°C) | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 | 25<br>0.6 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 |
| D.O. (mg/l) | 8.1<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.1<br>0.1 | 8.2<br>0.1 |
| PH (S.U.) | 8.02<br>0.09 | 8.04<br>0.09 | 8.06<br>0.08 | 8.07<br>0.08 | 8.08<br>0.07 | 8.08<br>0.06 | 8.08<br>0.06 | 8.09<br>0.07 |

Table 10. Reference Toxicant Test Data
(Reference Toxicant: KCl; Units: mg/l; CBI Stock Cultures)

| Species-Method (Ref. Test Date) | Data Source | % Control Survival | 48-h EC50 | 95% C.L./A.L. For EC50 | RTT in Control? |
|---|---|---|---|---|---|
| *C. dubia* 2002.0 | RTT | 95 | 615 | 574-658 | Yes |
| (3/12/12-3/14/12) | CC | 99 | 596 | 520-672 | |

Note: RTT = Reference Toxicant Test, CC = Control Chart.

**DISCUSSION:**

A WER value of 6.921 is obtained based on the ratio of the site EC50 to the hardness-adjusted SMAV.

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Coastal Bioanalysts, Inc.

## LITERATURE CITED:

EPA 1994. *Interim Guidance on Determination and Use of Water-effects Ratios for Metals.* February 1994. EPA-823-B-94-001.

EPA 2001. Streamlined Water-Effect Ratio Procedure for Discharges of Copper. EPA-822-R-01-005. United States Environmental Protection Agency, Office of Water, March 2001.

## GLOSSARY OF TERMS AND ABBREVIATIONS:

**A.L. (Acceptance Limits):** The results of a given reference toxicant test are compared to the control chart mean value ± 2 standard deviations. These limits approximate the 95% probability limits for the "true" reference toxicant value.

**C.L. (Confidence Limits):** These are the probability limits, based on the data set and statistical model employed, that the "true value" lies within the limits specified. Typically limits are based on 95% or 99% probabilities.

**Control chart:** A cumulative summary chart of results from QC tests with reference toxicants. The results of a given reference toxicant test are compared to the control chart mean value and 95% Acceptance Limits (A.L.) (mean ± 2 standard deviations).

**EC50/LC50:** The concentration of sample or chemical, calculated from the data set using statistical models, causing a 50% reduction in test organism survival or mobilization. The lower the EC50/ LC50, the more toxic the chemical or sample. Units are same as test concentration units. Note: The LC50 or EC50 value must always be associated with the duration of exposure.

**N/A:** Not applicable. **N/D:** Not determined or measured.

**Q.L.:** Quantitation Limit. Level, concentration, or quantity of a target variable (analyte) that can be reported at a specified degree of confidence.

**Species Mean Acute Value (SMAV):** Mean value of hardness-normalized EC50 values. Used in the criteria document for calculation of water quality criteria.

**Water-Effect Ratio (WER):** A criteria adjustment factor accounting for the effect of site-specific water characteristics on pollutant bioavailability and toxicity to aquatic life (from EPA 2001).



VELAP# 460030
EPA# VA01116

NELAP ACCREDITED LABORATORY

Client: Environmental Systems Service, LTD.
Project ID: ESSL1205
Client Sample ID: Madiera School Outfall 001
Permit No: VA0024120
Sample Period: 4/3/12

C B 1

Coastal Bioanalysts, Inc.

The results of analysis contained within this report relate only to the sample as received in the laboratory. This report shall not be reproduced except in full without written approval from the laboratory. Unless noted below, these test results meet all requirements of NELAP.

APPROVED:

Peter F. De Lisle, Ph.D.
Technical Director

4/18/12
Date

Deviations from, additions to, or exclusions from the test method, non-standard conditions or data qualifiers and, as appropriate, a statement of compliance/non-compliance: **NONE**



VELAP# 460030
EPA# VA01116

NELAP ACCREDITED LABORATORY

| Parameter | Treatment I.D. | Day 0 | Day 1 | Day 2 |
|---|---|---|---|---|
| Temp. (°C) | C | 25 | 24 | 25 |
| | 1 | 25 | 24 | 25 |
| | 2 | 25 | 24 | 25 |
| | 3 | 25 | 24 | 25 |
| | 4 | 25 | 24 | 25 |
| | 5 | 25 | 24 | 25 |
| | 6 | 25 | 24 | 25 |
| | 7 | 25 | 24 | — |
| pH (S.U.) | C | 8.01 | 7.97 | 7.85 |
| | 1 | 8.02 | 7.97 | 7.89 |
| | 2 | 8.02 | 7.97 | 7.94 |
| | 3 | 8.02 | 7.97 | 7.99 |
| | 4 | 8.02 | 7.97 | 8.01 |
| | 5 | 8.02 | 7.99 | 8.01 |
| | 6 | 8.03 | 7.99 | 8.01 |
| | 7 | 8.03 | 7.97 | — |
| D.O. (mg/l) | C | 8.2 | 8.2 | 8.0 |
| | 1 | 8.2 | 8.2 | 8.0 |
| | 2 | 8.2 | 8.0 | 8.1 |
| | 3 | 8.2 | 8.1 | 8.1 |
| | 4 | 8.2 | 8.1 | 8.1 |
| | 5 | 8.2 | 8.1 | 8.0 |
| | 6 | 8.2 | 8.1 | 8.0 |
| | 7 | 8.2 | 8.2 | — |
| Conduct. (Us/cm) | C | 475 | | 481 |
| | 1 | 475 | | |
| | 2 | 477 | | |
| | 3 | 477 | | |
| | 4 | 478 | | |
| | 5 | 478 | | |
| | 6 | 477 | | 480 |
| | 7 | 478 | | — |
| Replicate Meas.: | | S | S | S |
| Initials: | | CB | CB | CB |
| TRC (mg/l) in highest conc. at end of test: | | | | NA |

**Species:** *Ceriodaphnia dubia*

**Source:** **CBI stock cultures** ✓

**Other:** _____

**Brood Release:** **Date/time start:** 4/4/12 1640

**Date /time end:** 4/5/12 1300

**Acclimation:** **Water:** Mod. hard syn. FW ___

Other 120 mg/L hard SFW

**Temperature (°C):** 25

**Feeding:** **Prior to test:** YCT/*Selenastrum*
**During test:** Not Fed

**Illumination:** 16L:8D 10-20 uE/$m^2$/s

**Test chamber size:** ✓ 30 ml

**Solution volume:** ✓ 15 ml _____ ml

**Number of replicates/treatment:** 6

**Initial number of daphnids/replicate:** 5

**Template number:** NA

**Set up:** **Date (Day 0):** 4/5/12

**Time water added:** 1045

**Time daphnids added:** 1605

**Set up by (initials):** CB

*CERIODAPHNIA DUBIA* STATIC ACUTE TEST - WER
FORM ETF1051WER

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 2/9/09

| Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| Control | C-a | 5 | 5 | 4 | 96.7 |
| | C-b | 5 | 5 | 5 | |
| | C-c | 5 | 5 | 5 | |
| | C-d | 5 | 5 | 5 | |
| | C-e | 5 | 5 | 5 | |
| | C-f | 5 | 5 | 5 | |
| 5.88 | 1-a | 5 | 5 | 5 | 100 |
| | 1-b | 5 | 5 | 5 | |
| | 1-c | 5 | 5 | 5 | |
| | 1-d | 5 | 5 | 5 | |
| | 1-e | 5 | 5 | 5 | |
| | 1-f | 5 | 5 | 5 | |
| 8.40 | 2-a | 5 | 5 | 5 | 100 |
| | 2-b | 5 | 5 | 5 | |
| | 2-c | 5 | 5 | 5 | |
| | 2-d | 5 | 5 | 5 | |
| | 2-e | 5 | 5 | 5 | |
| | 2-f | 5 | 5 | 5 | |
| 12.0 | 3-a | 5 | 5 | 5 | 100 |
| | 3-b | 5 | 5 | 5 | |
| | 3-c | 5 | 5 | 5 | |
| | 3-d | 5 | 5 | 5 | |
| | 3-e | 5 | 5 | 5 | |
| | 3-f | 5 | 5 | 5 | |

| Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| 17.2 | 4-a | 5 | 5 | 5 | 96.7 |
| | 4-b | 5 | 5 | 4 | |
| | 4-c | 5 | 5 | 5 | |
| | 4-d | 5 | 5 | 5 | |
| | 4-e | 5 | 5 | 5 | |
| | 4-f | 5 | 5 | 5 | |
| 24.5 | 5-a | 5 | 5 | 2 | 33.3 |
| | 5-b | 5 | 5 | 2 | |
| | 5-c | 5 | 5 | 1 | |
| | 5-d | 5 | 5 | 1 | |
| | 5-e | 5 | 5 | 2 | |
| | 5-f | 5 | 5 | 2 | |
| 35.0 | 6-a | 5 | 0 | 0 | 0 |
| | 6-b | 5 | 0 | 0 | |
| | 6-c | 5 | 1 | 0 | |
| | 6-d | 5 | 2 | 0 | |
| | 6-e | 5 | 1 | 0 | |
| | 6-f | 5 | 1 | 0 | |
| 50.0 | 7-a | 5 | 0 | 0 | 0 |
| | 7-b | 5 | 0 | 0 | |
| | 7-c | 5 | 0 | 0 | |
| | 7-d | 5 | 0 | 0 | |
| | 7-e | 5 | 0 | 0 | |
| | 7-f | 5 | 0 | 0 | |
| | Initials: | CB | CB | CB | |
| | Count Time: | 1405 | 1430 | 1600 | *Test end time |

Peer Rev by: PB Date: 4/16/12

0.7 X dilution factor (2L highest conc; pour off 600ml each dilution)

Highest conc = 100ml Cu stock in 2L hard SFW

 Test ID: ESSL1205 ACD-WER Site Water ___ Lab Water ✓

## Acute Ceriodaphnia Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/5/2012 16:05 | Test ID: | ESSL1205L | Sample ID: | MADIERA SCHOOL 001 WER |
| End Date: | 4/7/2012 16:00 | Lab ID: | CBI | Sample Type: | LAB WATER (NOMINAL CU) |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

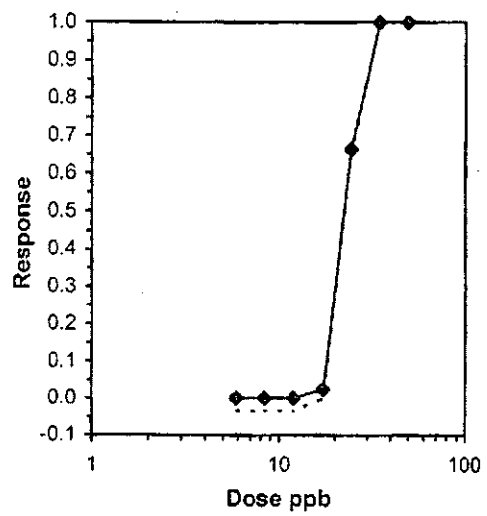
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 0.8000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 5.88 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 8.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 17.2 | 1.0000 | 0.8000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 24.5 | 0.4000 | 0.4000 | 0.2000 | 0.2000 | 0.4000 | 0.4000 |
| 35 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 0.9667 | 1.0000 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 5.88 | 1.0000 | 1.0345 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 8.4 | 1.0000 | 1.0345 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 12 | 1.0000 | 1.0345 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 17.2 | 0.9667 | 1.0000 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 24.5 | 0.3333 | 0.3448 | 0.6110 | 0.4636 | 0.6847 | 18.683 | 6 | 20 | 30 |
| 35 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.69422 | 0.912 | -1.9445 | 3.54965 |
| Equality of variance cannot be confirmed | | | | |

**Trimmed Spearman-Karber**

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 22.924 | 21.490 | 24.454 |
| 5.0% | 22.896 | 21.387 | 24.512 |
| 10.0% | 22.773 | 21.141 | 24.531 |
| 20.0% | 22.550 | 20.646 | 24.630 |
| Auto-0.0% | 22.924 | 21.490 | 24.454 |






ToxCalc v5.0.23

Reviewed by: [illegible]

## Acute Fish Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/5/2012 16:05 | Test ID: | ESSL1205LM | Sample ID: | MADIERA SC |
| End Date: | 4/7/2012 16:00 | Lab ID: | CBI | Sample Type: | LAB WATER MEASURED COPPER |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

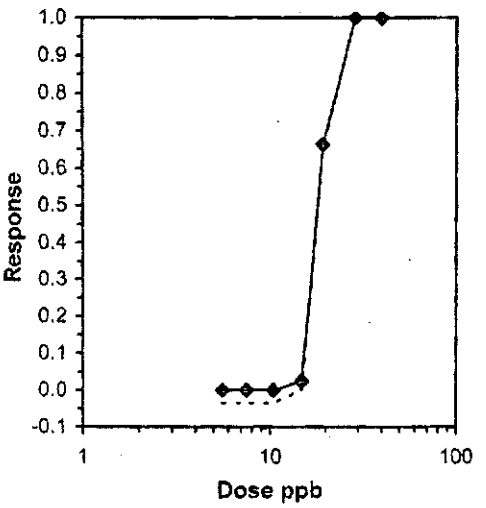
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 0.8000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 5.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 7.48 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 10.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 14.8 | 1.0000 | 0.8000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 19.4 | 0.4000 | 0.4000 | 0.2000 | 0.2000 | 0.4000 | 0.4000 |
| 29 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 40.3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 0.9667 | 1.0000 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 5.6 | 1.0000 | 1.0345 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 7.48 | 1.0000 | 1.0345 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 10.4 | 1.0000 | 1.0345 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 14.8 | 0.9667 | 1.0000 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 19.4 | 0.3333 | 0.3448 | 0.6110 | 0.4636 | 0.6847 | 18.683 | 6 | 20 | 30 |
| 29 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |
| 40.3 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.69422 | 0.912 | -1.9445 | 3.54965 |
| Equality of variance cannot be confirmed | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 18.824 | 17.716 | 20.002 |
| 5.0% | 18.746 | 17.581 | 19.987 |
| 10.0% | 18.592 | 17.344 | 19.930 |
| 20.0% | 18.316 | 16.917 | 19.830 |
| Auto-0.0% | 18.824 | 17.716 | 20.002 |



| Parameter | Treatment I.D. | Day 0 | Day 1 | Day 2 |
|---|---|---|---|---|
| Temp. (°C) | C | 25 | 24 | 25 |
| | 1 | 25 | 24 | 25 |
| | 2 | 25 | 24 | 25 |
| | 3 | 25 | 24 | 25 |
| | 4 | 25 | 25 | 25 |
| | 5 | 25 | 25 | 25 |
| | 6 | 25 | 25 | 25 |
| | 7 | 25 | 25 | 25 |
| pH (S.U.) | C | 8.01 | 7.94 | 8.12 |
| | 1 | 8.02 | 7.96 | 8.13 |
| | 2 | 8.04 | 7.99 | 8.15 |
| | 3 | 8.04 | 8.02 | 8.14 |
| | 4 | 8.04 | 8.03 | 8.14 |
| | 5 | 8.04 | 8.05 | 8.15 |
| | 6 | 8.04 | 8.05 | 8.15 |
| | 7 | 8.04 | 8.07 | 8.17 |
| D.O. (mg/l) | C | 8.2 | 8.1 | 8.1 |
| | 1 | 8.2 | 8.1 | 8.1 |
| | 2 | 8.2 | 8.1 | 8.1 |
| | 3 | 8.2 | 8.0 | 8.1 |
| | 4 | 8.2 | 8.0 | 8.0 |
| | 5 | 8.2 | 8.0 | 8.0 |
| | 6 | 8.2 | 8.1 | 8.1 |
| | 7 | 8.2 | 8.1 | 8.2 |
| Conduct. (Us/cm) | C | 853 | | 859 |
| | 1 | 861 | | |
| | 2 | 861 | | |
| | 3 | 862 | | |
| | 4 | 862 | | |
| | 5 | 863 | | |
| | 6 | 863 | | |
| | 7 | 863 | | 869 |
| Replicate Meas.: | | S | S | S |
| Initials: | | GB | GB | GB |
| TRC (mg/l) in highest conc. at end of test: | | | | NA |

**Species:** *Ceriodaphnia dubia*

**Source:** **CBI stock cultures** ✓

**Other:** _____

**Brood Release:** **Date/time start:** 4/4/12 1640

**Date /time end:** 4/5/12 1300

**Acclimation:** **Water:** Mod. hard syn. FW____

Other 120 mg/L hard SAW

**Temperature (°C):** 25

**Feeding:** **Prior to test:** YCT/*Selenastrum*
**During test:** Not Fed

**Illumination:** 16L:8D 10-20 uE/$m^2$/s

**Test chamber size:** ✓ **30 ml**

**Solution volume:** ✓ **15 ml** _____ **ml**

**Number of replicates/treatment: 6**

**Initial number of daphnids/replicate: 5**

**Template number:** NA

**Set up:** **Date (Day 0):** 4/5/12

**Time water added:** 1055

**Time daphnids added:** 1620

**Set up by (initials):** GB

| Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| Control | C-a | 5 | 5 | 5 | 100 |
| | C-b | 5 | 5 | 5 | |
| | C-c | 5 | 5 | 5 | |
| | C-d | 5 | 5 | 5 | |
| | C-e | 5 | 5 | 5 | |
| | C-f | 5 | 5 | 5 | |
| 58.8 | 1-a | 5 | 5 | 5 | 100 |
| | 1-b | 5 | 5 | 5 | |
| | 1-c | 5 | 5 | 5 | |
| | 1-d | 5 | 5 | 5 | |
| | 1-e | 5 | 5 | 5 | |
| | 1-f | 5 | 5 | 5 | |
| 84.0 | 2-a | 5 | 5 | 5 | 100 |
| | 2-b | 5 | 5 | 5 | |
| | 2-c | 5 | 5 | 5 | |
| | 2-d | 5 | 5 | 5 | |
| | 2-e | 5 | 5 | 5 | |
| | 2-f | 5 | 5 | 5 | |
| 120 | 3-a | 5 | 5 | 5 | 100 |
| | 3-b | 5 | 5 | 5 | |
| | 3-c | 5 | 5 | 5 | |
| | 3-d | 5 | 5 | 5 | |
| | 3-e | 5 | 5 | 5 | |
| | 3-f | 5 | 5 | 5 | |

| Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| 172 | 4-a | 5 | 5 | 5 | 96.7 |
| | 4-b | 5 | 5 | 5 | |
| | 4-c | 5 | 5 | 5 | |
| | 4-d | 5 | 5 | 5 | |
| | 4-e | 5 | 5 | 4 | |
| | 4-f | 5 | 5 | 5 | |
| 245 | 5-a | 5 | 5 | ①~~8~~ 3 | 40 |
| | 5-b | 5 | 5 | 1 | |
| | 5-c | 5 | 5 | 3 | |
| | 5-d | 5 | 5 | 2 | |
| | 5-e | 5 | 5 | 1 | |
| | 5-f | 5 | 5 | 2 | |
| 350 | 6-a | 5 | 5 | 0 | 33 |
| | 6-b | 5 | 5 | 0 | |
| | 6-c | 5 | 5 | 0 | |
| | 6-d | 5 | 5 | 1 | |
| | 6-e | 5 | 5 | 0 | |
| | 6-f | 5 | 5 | 0 | |
| 500 | 7-a | 5 | 5 | 0 | 0 |
| | 7-b | 5 | 5 | 0 | |
| | 7-c | 5 | 5 | 0 | |
| | 7-d | 5 | 5 | 0 | |
| | 7-e | 5 | 3 | 0 | |
| | 7-f | 5 | 4 | 0 | |
| | Initials: | GB | GB | GB | |
| | Count Time: | 1620 | 1020 | 1620 | Test end time |

Peer Rev by: PB Date: 4/16/12

0.7X dilution factor (2L highest conc; pour off 600 ml each dilution)

Highest conc = 1000mL Cu stock in 2L effluent

①4/17/12 GB

 Test ID: ESSL1205 ACD-WER Site Water ✓ Lab Water ____

## Acute Ceriodaphnia Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/5/2012 16:20 | Test ID: | ESSL1205S | Sample ID: | MADIERA SCHOOL 001 WER |
| End Date: | 4/7/2012 16:20 | Lab ID: | CBI | Sample Type: | SITE WATER (NOMINAL CU) |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

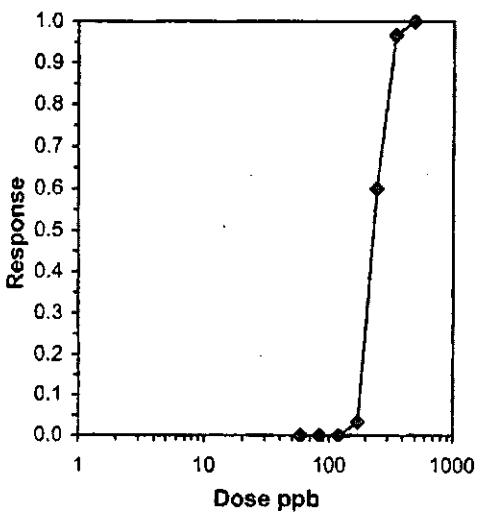
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 58.8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 84 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 120 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 172 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.8000 | 1.0000 |
| 245 | 0.6000 | 0.2000 | 0.6000 | 0.4000 | 0.2000 | 0.4000 |
| 350 | 0.0000 | 0.0000 | 0.0000 | 0.2000 | 0.0000 | 0.0000 |
| 500 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 58.8 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 84 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 120 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 172 | 0.9667 | 0.9667 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 245 | 0.4000 | 0.4000 | 0.6781 | 0.4636 | 0.8861 | 27.868 | 6 | 18 | 30 |
| 350 | 0.0333 | 0.0333 | 0.2652 | 0.2255 | 0.4636 | 36.658 | 6 | 29 | 30 |
| 500 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.7164 | 0.922 | -0.0828 | 3.8312 |
| Equality of variance cannot be confirmed | | | | |

Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 236.62 | 220.26 | 254.19 |
| 5.0% | 235.70 | 219.20 | 253.44 |
| 10.0% | 234.73 | 216.67 | 254.29 |
| 20.0% | 232.86 | 210.68 | 257.38 |
| Auto-0.0% | 236.62 | 220.26 | 254.19 |






ToxCalc v5.0.23

Reviewed by:

## Acute Fish Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/5/2012 16:20 | Test ID: | ESSL1205SM | Sample ID: | MADIERA SC |
| End Date: | 4/7/2012 16:20 | Lab ID: | CBI | Sample Type: | SITE WATER MEASURED CU |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

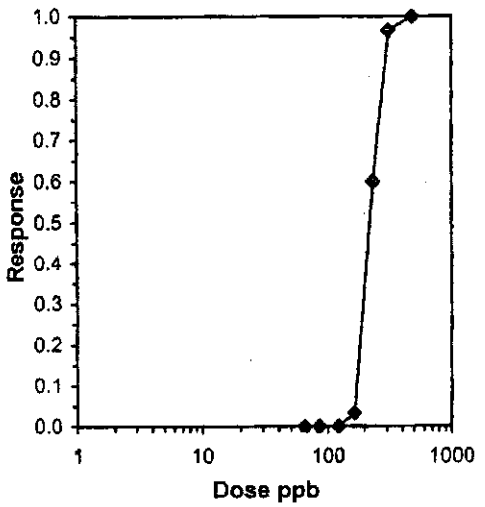
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 65.2 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 84.6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 123 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 166 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.8000 | 1.0000 |
| 236 | 0.6000 | 0.2000 | 0.6000 | 0.4000 | 0.2000 | 0.4000 |
| 313 | 0.0000 | 0.0000 | 0.0000 | 0.2000 | 0.0000 | 0.0000 |
| 486 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 65.2 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 84.6 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 123 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 166 | 0.9667 | 0.9667 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 236 | 0.4000 | 0.4000 | 0.6781 | 0.4636 | 0.8861 | 27.868 | 6 | 18 | 30 |
| 313 | 0.0333 | 0.0333 | 0.2652 | 0.2255 | 0.4636 | 36.658 | 6 | 29 | 30 |
| 486 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.7164 | 0.922 | -0.0828 | 3.8312 |
| Equality of variance cannot be confirmed | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 224.96 | 210.79 | 240.09 |
| 5.0% | 224.06 | 209.99 | 239.06 |
| 10.0% | 223.66 | 208.18 | 240.29 |
| 20.0% | 222.90 | 203.51 | 244.13 |
| Auto-0.0% | 224.96 | 210.79 | 240.09 |






ToxCalc v5.0.23

Reviewed by:

*CERIODAPNIA DUBIA* WER RANGE-FINDING TEST
FORM ETF1051WER RFT

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 2/9/09

| Lab Water RFT | | | | | |
|---|---|---|---|---|---|
| Nominal Cu ug/l | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
| Lab Control | C-A | 5 | 5 | 5 | 100 |
| | C-B | 5 | 5 | 5 | |
| 1.57 | 1-A | 5 | 5 | 5 | 100 |
| | 1-B | 5 | 5 | 5 | |
| 3.13 | 2-A | 5 | 5 | 5 | 100 |
| | 2-B | 5 | 5 | 5 | |
| 6.25 | 3-A | 5 | 5 | 5 | 100 |
| | 3-B | 5 | 5 | 5 | |
| 12.5 | 4-A | 5 | 5 | 5 | 100 |
| | 4-B | 5 | 5 | 5 | |
| 25.0 | 5-A | 5 | 1 | 0 | 0 |
| | 5-B | 5 | 0 | 0 | |
| 50.0 | 6-A | 5 | 0 | 0 | 0 |
| | 6-B | 5 | 0 | 0 | |
| 100 | 7-A | 5 | 0 | 0 | 0 |
| | 7-B | 5 | 0 | 0 | |
| Initials: | | GB | PB | GB | |
| Count Time: | | 1710 | 1645 | 0855 | *Test End Time |

| Site Water RFT | | | | | |
|---|---|---|---|---|---|
| Nominal Cu ug/l | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
| Site Control | S-A | 5 | 5 | 5 | 100 |
| | S-B | 5 | 5 | 5 | |
| 12.5 | 1-A | 5 | 5 | 5 | 100 |
| | 1-B | 5 | 5 | 5 | |
| 25.0 | 2-A | 5 | 5 | 5 | 100 |
| | 2-B | 5 | 5 | 5 | |
| 50.0 | 3-A | 5 | 5 | 5 | 100 |
| | 3-B | 5 | 5 | 5 | |
| 100 | 4-A | 5 | 5 | 5 | 100 |
| | 4-B | 5 | 5 | 5 | |
| 200 | 5-A | 5 | 3 | 3 | 70 |
| | 5-B | 5 | 4 | 4 | |
| 400 | 6-A | 5 | 0 | 0 | 0 |
| | 6-B | 5 | 0 | 0 | |
| 800 | 7-A | 5 | 0 | 0 | 0 |
| | 7-B | 5 | 0 | 0 | |
| Initials: | | GB | PB | GB | |
| Count Time: | | 1445 | 1635 | 0845 | *Test End Time |

**Species:** *Ceriodaphnia dubia*

**Source:** **CBI stock cultures** ✓

**Other:** _____

**Brood Release:** **Date/time start:** 4/2/12 2040

**Date /time end:** 4/3/12 0950

**Acclimation:** **Water:** Mod. hard syn. FW ✓

Other _____

**Temperature (°C):** 25

**Feeding:** **Prior to test:** YCT/*Selenastrum*
**During test:** Not Fed

**Illumination:** 16L:8D 10-20 uE/m$^2$/s

**Test chamber size:** ✓ 30 ml

**Solution volume:** ✓ 15 ml _____ ml

**Number of replicates/treatment:** 2

**Initial number of daphnids/replicate:** 5

**Template number:** NA

**Set up:** **Date (Day 0):** 4/3/12

**Time water added:** 1635

**Time daphnids added:** 1645 - 1710

**Set up by (initials):** GB

| End of Test Water Qual. | Lab Water | | Site Water | |
|---|---|---|---|---|
| | Control | Mort* | Control | Mort* |
| Temp (°C) | 25 | 25 | 25 | 25 |
| pH | 8.03 | 8.01 | 8.05 | 8.12 |
| D.O. (mg/l) | 8.2 | 8.3 | 8.1 | 8.1 |
| Cond. (uS) | 473 | 490 | 843 | 864 |

*Mort=Lowest concentration with 100% mortality at end of test

Peer Rev. by: GB/PB Date: 4/7/12

TEST I.D.(Date) ESSC1205 WER-RFT

## Acute Ceriodaphnia Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/3/2012 16:45 | Test ID: | ESSL1205LR | Sample ID: | MADIERA SCHOOL 001 WER |
| End Date: | 4/5/2012 08:55 | Lab ID: | CBI | Sample Type: | LAB WATER RANGE FINDING |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

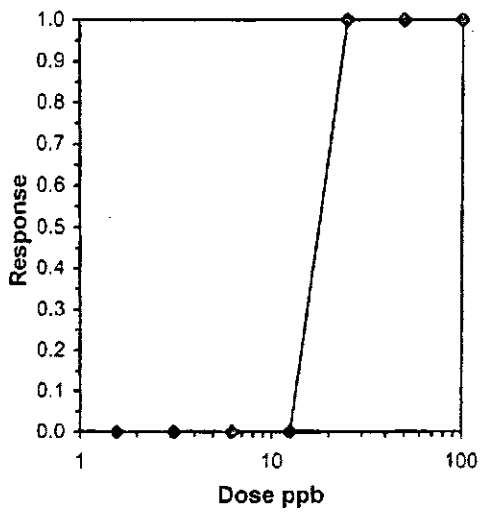
| Conc-ppb | 1 | 2 |
|---|---|---|
| CONTROL | 1.0000 | 1.0000 |
| 1.57 | 1.0000 | 1.0000 |
| 3.13 | 1.0000 | 1.0000 |
| 6.25 | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 |
| 25 | 0.0000 | 0.0000 |
| 50 | 0.0000 | 0.0000 |
| 100 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 1.57 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 3.13 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 6.25 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 12.5 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 25 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 2 | 10 | 10 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 2 | 10 | 10 |
| 100 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 2 | 10 | 10 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Normality of the data set cannot be confirmed | | | | |
| Equality of variance cannot be confirmed | | | | |

### Graphical Method

| Trim Level | EC50 |
|---|---|
| 0.0% | 17.678 |
| | 17.678 |








Reviewed by: PB

## Acute Ceriodaphnia Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 4/3/2012 16:45 | Test ID: | ESSL1205SR | Sample ID: | MADIERA SCHOOL 001 WER |
| End Date: | 4/5/2012 08:55 | Lab ID: | CBI | Sample Type: | SITE WATER RANGE FINDING |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

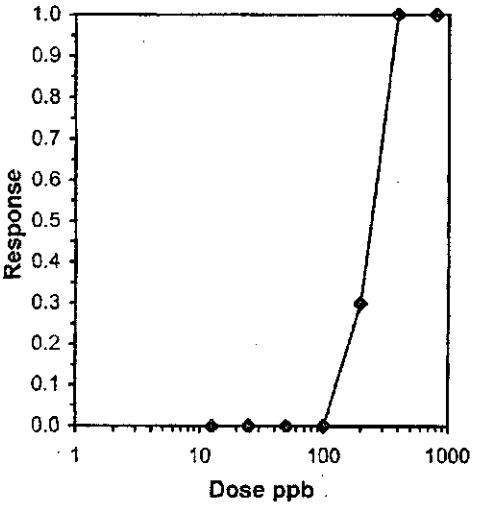
| Conc-ppb | 1 | 2 |
|---|---|---|
| CONTROL | 1.0000 | 1.0000 |
| 12.5 | 1.0000 | 1.0000 |
| 25 | 1.0000 | 1.0000 |
| 50 | 1.0000 | 1.0000 |
| 100 | 1.0000 | 1.0000 |
| 200 | 0.6000 | 0.8000 |
| 400 | 0.0000 | 0.0000 |
| 800 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 12.5 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 25 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 50 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 100 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 2 | 0 | 10 |
| 200 | 0.7000 | 0.7000 | 0.9966 | 0.8861 | 1.1071 | 15.685 | 2 | 3 | 10 |
| 400 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 2 | 10 | 10 |
| 800 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 2 | 10 | 10 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Normality of the data set cannot be confirmed | | | | |
| Equality of variance cannot be confirmed | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 229.74 | 187.93 | 280.86 |
| 5.0% | 232.88 | 185.82 | 291.86 |
| 10.0% | 235.89 | 181.43 | 306.70 |
| 20.0% | 241.14 | 162.36 | 358.14 |
| Auto-0.0% | 229.74 | 187.93 | 280.86 |






ToxCalc v5.0.23

Reviewed by:

EFFLUENT, STREAM & DILUTION WATER CHARACTERISTICS
FORM ETF2031WER

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 2/9/09

| INITIAL SAMPLE CHARACTERIZATION[1] | | | |
|---|---|---|---|
| Source | Effluent | Stream | Site = effluent |
| Tot. Res. Chlorine (mg/l) | <QL | NA | NA |
| Hardness (mg/l $CaCO_3$) | 138 | | |
| Alkalinity (mg/l $CaCO_3$) | 147 | | |
| $NH_3$-N (mg/l) | L1.0 | | |
| Color/Appearance[2] | CY | | |
| Obvious Odor? | ND | | |
| Date/Initials | 4/3 GB | | |

| DILUTION WATER CHARACTERISTICS | | |
|---|---|---|
| Test | Range-finding | Definitive |
| Temperature (°C) | 25 | 25 |
| Conductivity (uS/cm) | 473 | 475 |
| D.O. (mg/l) | 8.2 | 8.2 |
| pH (S.U.) | 7.93 | 7.91 |
| Hardness (mg/l $CaCO_3$) | 138 | 138 |
| Alkalinity (mg/l $CaCO_3$) | 74 | 74 |
| $NH_3$-N (mg/l) | L1.0 | L1.0 |
| Date/Initials | 4/3 GB | 4/5 GB |

| SAMPLE PREPARATION MEASUREMENTS (100% concentration) | | | |
|---|---|---|---|
| Test | Range-finding | Definitive | |
| Source | Site (Mix) = effluent 100% | Effluent | Stream |
| Prep Temperature (°C) | 25 | 25 | NA |
| Conductivity (uS/cm) | 842 | 843 | |
| D.O. (mg/l) After Warming | 9.6 | 10.2 | |
| Aeration Time (min) | 20 | 2.5 | |
| Adjusted D.O. | 8.2 | 8.2 | |
| Final pH (S.U.) | 7.89 | 7.93 | |
| Tot. Res. Chlorine (mg/l)[3] | n.d. | N.D. | |
| Sample Filtered (60 um)? | no | ND | |
| Date/Time | 4/3 1605 | 4/5 1000 | |
| Initials | PB | GB | |

Toxicant: $CuCl_2 \cdot 2H_2O$ } B5Stock B15Y
"A" Bottle # 328 (10.00)
Bal. Calib. Chk: 100 mg wt: 100.00

Stock = 67 mg/ 25 ml*

Prepared by: GB Date: 4/2/12

RANGE-FINDING TEST:
Highest Concentration = 80 ul in 100 ml Site water

Prepared by: GB Date: 4/3/12

DEFINITIVE TEST:
Highest Concentration = 1000 ul in 2000 ml Effluent

Prepared by: GB Date: 4/5/12

*As total compound. As toxic component = 1mg/ml

Preparation of test solutions (definitive test)

| Test Procedure | Site water | Lab Water |
|---|---|---|
| Dilution factor: | 0.7X | 0.7X |
| Volume diluted spiked effluent or SFW added to each conc. prep flask: | 600ml | 600ml |
| Time diluted spiked effluent or SFW added: | 1055 | 1045 |
| Volume stream water added to each flask of spiked effluent: | NA | |
| Time stream water added to each flask of spiked effluent: | NA | |

NOTES:

[1]Q.L. = Quantification Limit, N.D. = Not Determined/Measured, NA = Not Applicable
[2]C-Clear, O-Opaque, T-Turbid, S-Solids (Sl-Slight, M-Moderate, H-Heavy), Y-Yellow, B-Brown, Bl-Black, G-Green
[3]Total residual chlorine measured after sample prep only if present in initial sample characterization

Peer Rev by PB/GB Date 4/10/12 PROJECT I.D. E55L1205 WER
(First 8 characters of Laboratory Sample ID)

ESSL1205-A 12-0270

ESS WO #_____

ESS PO #_____

# BIOASSAY CHAIN OF CUSTODY

Customer Madeira School VPDES Permit # VA0024120

Outfall/Location Outfall 001

## SAMPLE INFORMATION

**GRAB**

Collection: Date _____ Time _____

Sample volume _____ Flow rate _____

Effluent: pH (SU) _____ Temp (°C) _____ Chlorine (mg/l) _____

Dissolved $O_2$ (mg/l) _____ Conductivity (indicate unit) _____

Analysis (Date/Time) _____

**COMPOSITE**

Collection: From (Date/Time): 4/3/12 0705 To (Date/Time): 4/3/12 1105

# of samples 5 - 4hr Comp Volume 5gal Flow rate avg. 16.4gpm

Auto-sampler temperature (°C) N/A

Effluent: pH (SU) 7.606 Temp (°C) 14.1 Chlorine (mg/l) N/A

Dissolved $O_2$ (mg/l) 11.10

Analysis (Date/Time) 0816 4/3/12

Sampler's Signature _____

Received at ESS Lab by: _____ Date _____ Time _____

Delivery method to Bioassay Lab: _____ Coolant used: _____

Received at Coastal Lab by: _____ Date 4/3/12 Time 1550

Temperature of sample upon receipt @ Coastal Lab: 1°C

| | | |
|---|---|---|
| ____ | Chronic | *Ceriodaphnia dubia* |
| ____ | Chronic | *Pimephales promelas* |
| ____ | Acute | *Ceriodaphnia dubia* |
| ____ | Acute | *Pimephales promelas* |

# SAMPLE CHAIN OF CUSTODY RECORD


Company _ Environmental System Services
Contact __ Cody Hoehna
Address __ 218 North Main Street
Address __ Culpeper, Va 22701
Phone ____ 540-825-6660


## ENVIRONMENTAL SYSTEMS SERVICE, LTD.


| 218 North Main St. | 500 Stone St. | 8321 Leishear Road | 3917 Westpoint Blvd. |
|---|---|---|---|
| Post Office Box 520 | Post Office Box 736 | Laurel, MD 20723 | Suite E |
| Culpeper, VA 22701 | Bedford, VA 24523 | | Winston-Salem, NC 27103 |
| 800-541-2116 | 540-586-5413 | 301-617-9582 | 910-659-3378 |
| 540-825-6660 | Fax 540-586-5530 | Fax 301-617-3426 | Fax 910-659-3379 |


**Project Name/Site __ The Madeira School WER Study** P.O.# 13851

**Sampled By:** Geordy Biggs/Pam Blasco (Print Name) Geordy Biggs Pamela Blasco (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES TR Cu | | | | | | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ✓ | 4/15/12 | 1515 | Lab control | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| | 4/15/12 | 1515 | 5.88 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| | 4/15/12 | 1515 | 8.40 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| | 4/15/12 | 1515 | 12.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| ✓ | 4/15/12 | 1515 | 17.2 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| ✓ | 4/15/12 | 1515 | 24.5 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| ✓ | 4/15/12 | 1515 | 35.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| | 4/15/12 | 1515 | 50.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | Preservative |
| ✓ | 4/15/12 | 1530 | Site (eff) control | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | pH Check: |
| | 4/15/12 | 1530 | 58.8 ppb site (eff) | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| | 4/15/12 | 1530 | 84.0 ppb site (eff) | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |
| ✓ | 4/15/12 | 1530 | 120 ppb site (eff) | 250mL | P | 1 | x | | ww | HNO3 | x | | | | | | | | | |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| D. Biggs | 4/15/12 | 1540 | UPS | | | | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | | | |

Method of Delivery
☐ UPS ☐ Fed Ex ☐ Hand Delivery
☐ UPS Overnight ☐ Post Office

Remarks:
Received @ _____ C
☐ Under 2 hours

TAT
Normal ____ Rush ____
Need Results by _____
Extra charges will apply for Rush TAT.

W.O.# _____
W.O.# _____

Amt Paid $_____
Check # _____

Revised 11/04/04

# SAMPLE CHAIN OF CUSTODY RECORD

Company _ Environmental System Services
Contact __ Cody Hoehna
Address __ 218 North Main Street
Address __ Culpeper, Va 22701
Phone ___ 540-825-6660

## ENVIRONMENTAL SYSTEMS SERVICE, LTD.

| | | | |
|---|---|---|---|
| 218 North Main St. | 500 Stone St. | 8321 Leishear Road | 3917 Westpoint Blvd. |
| Post Office Box 520 | Post Office Box 736 | Laurel, MD 20723 | Suite E |
| Culpeper, VA 22701 | Bedford, VA 24523 | | Winston-Salem, NC 27103 |
| 800-541-2118 | 540-586-5413 | 301-617-9582 | 910-659-3378 |
| 540-825-6660 | Fax 540-586-5630 | Fax 301-617-3426 | Fax 910-659-3379 |

Project Name/Site __ The Madeira School WER Study P.O.# 13851

Sampled By: Georgi Bridges/Pamela Blasco (Print Name) Georgi Bridges/Pamela Blasco (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES TR Cu | TSS | DOC | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ✓ | 4/5/12 | 1530 | 172 ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| ✓ | 4/5/12 | 1530 | 245 ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| ✓ | 4/5/12 | 1530 | 350 ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| ✓ | 4/5/12 | 1530 | 500 ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| | 4/5/12 | 1535 | lab | 1L | P | 1 | x | | ww | None | | x | | |
| | 4/5/12 | 1535 | site/eff1 | 1L | P | 1 | x | | ww | None | | x | | |
| | 4/5/12 | 1535 | lab | 1L | G | 1 | x | | ww | H2SO4 | | | x | |
| | 4/5/12 | 1535 | site/eff1 | 1L | G | 1 | x | | ww | H2SO4 | | | x | Preservative |
| | | | | | | | | | | | | | | pH Check: |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| D. Bw | 4/5/12 | 1540 | UPS | | | | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | | | |

Method of Delivery
☐ UPS ☐ Fed Ex ☐ Hand Delivery
☐ UPS Overnight ☐ Post Office

Remarks:
Received @ _____ C
☐ Under 2 hours

TAT
Normal ____ Rush ____
Need Results by _____
Extra charges will apply for Rush TAT.

W.O.# _____
W.O.# _____

Amt Paid $_____
Check # _____

Revised 11/04/04

Tuesday 4/3/12

0650 DS + LM onsite for WEA Study

0720 OK on Site. D.O. meter On (a)

- Read Totalizers (Mon. 14:4) 134315 +10 (a)
  122344 +10
  18,710 Gal

- Pump Station
  Inf Pump 1: 789.0 (1.3)
  Inf Pump 2: 702.6 (1.0) (a)
  P/S GEN: 96 h 9m
  P/S Ops: Ok

0755 Cal. brake ~~DO~~ pH meter (a)
  1st 4.00 at 19.7° Chk 7.03 at 19.6°
  2nd 7.02 at 19.6° Slope 57.5 mV
  3rd 10.07 at 19.5°

0801 Cal. brake D.O. meter 9.01 at 19.9° (a)

0816 D.O. = 11.10 at 14.1°

0816 pH Samples Collected (a)

0821 pH = 7.66 at 13.8°/14.1°

- pH Readings (a)
  Inf 8.39 at 14.4°
  Train 1 Train 2
  1161 7.18 at 14.6° 7.41 at 14.5°

- Sodium Hyd Vat Refill 1516s

- D.O. Readings (a)
  Train 1 Train 2
  1181 7.62 at 14.7° 7.68 at 14.4°

- UV Hours (a)
  Bank 1 7492 (4.1)
  Bank 2 OFFLINE

- WWTP GEN 98 h 35 m

- Pump Hours - Record

1210 MLSS/MLVSS Samples Collected (a)
  1183 T1 + T2

Tuesday 4-5-13

- Bar Screen Brake
- EQ Junction Box - Ok
- Returns - Ok
- Elevators - Ok
- Filters - Ok

(a)

- Completed Daily Paperwork
- Final Checks

(a)

1020 OC Left Site

Collected Grab Samples for WER Study (DS)

1005 Hardness, E.Coli, Diss Cu, TR Cu

Composite Samples for Bioassay + weekly Samples

| | Flow | Factor Bioassay | Factor Samples | Volume | Initial |
|---|---|---|---|---|---|
| 0705 | 12.7 | 275 | 55 | 3490 : 700 | DS + LM |
| 0805 | 15.6 | 275 | 55 | 4290 : 858 | DS + LM |
| 0905 | 17.5 | 275 | 55 | 4810 : 962 | DS + LM |
| 1005 | 18.2 | 275 | 55 | 5000 : 1000 | DS + LM |
| 1105 | 18.6 | 275 | 55 | 5115 : 1023 | DS + LM |

0940 Collected Eff BOD, TSS, $NH_3$ + HEM

all day

1155 DS + LM collected

# ENVIRONMENTAL SYSTEMS SERVICE, LTD.

Page: 1

Work Order #: 24679
Contract #:
Customer #: 5780
Customer PO #:

MADEIRA SCHOOL
ATTN: ED HAMER
8328 GEORGETOWN PIKE
MC LEAN, VA 22102

Job Location:
Collected by: DILLON SHEADS
Date Received: 04/03/2012

## ANALYSIS REPORT

COMMENT: BOD SEED CORRECTION VALUE OUTSIDE OF ACCEPTANCE RANGE.

| TAG #: | SAMPLE POINT: | SAMPLE DATE: |
|---|---|---|
| 59653 | OUTFALL 001 | 04/03/2012 |

| Description | Result | Unit | Rpt. Limit | Method | Anlys Date | Time | Init |
|---|---|---|---|---|---|---|---|
| Biochemical Oxygen Demand | <2 | mg/l | 2 | SM 5210 | 04/04/12 | 16:15 | AW |
| Total Suspended Solids | <1.00 | mg/l | 1.00 | SM 2540D | 04/05/12 | 15:51 | JI |
| Ammonia, as N | <0.10 | mg/l | 0.10 | SM 4500NH3D | 04/06/12 | 15:15 | BW |
| Conductivity | 866 | umhos/cm | 2.0 | SM 2510 B | 04/12/12 | 14:00 | JW |
| Alkalinity as CaCO3 | 142 | mg/l | 5 | SM 2320 B | 04/09/12 | 13:30 | JI |
| Dissolved Organic Carbon | 4.50 | mg/l | 1 | SM 5310C | 04/10/12 | 08:00 | JLC |
| Total Organic Carbon* | 7.22 | mg/l | 1.00 | SM 5310C | 04/09/12 | 08:00 | JWB |

Reviewed by: Angie Woodward
A. Woodward/Technical Director

Report Date: April 18, 2012
VA LAB ID# 460019
* Subcontracted test

# ENVIRONMENTAL SYSTEMS SERVICE, LTD.

Page: 1

Work Order #: 24679
Contract #:
Customer #: 5780
Customer PO #:

MADEIRA SCHOOL
ATTN: ED HAMER
8328 GEORGETOWN PIKE
MC LEAN, VA 22102

Job Location:
Collected by: DILLON SHEADS
Date Received: 04/03/2012

## ANALYSIS REPORT

| TAG #: | SAMPLE POINT: | SAMPLE DATE: |
|---|---|---|
| 59654 | OUTFALL 001 | 04/03/2012 |

| Description | Result | Unit | Rpt. Limit | Method | Anlys Date | Time | Ini |
|---|---|---|---|---|---|---|---|
| Copper, Total Recoverable* | 0.0149 | mg/l | 0.0050 | EPA 200.8 | 04/07/12 | 14:07 | JRM |
| Escherichia coli (100 ml) | <1 | MPN | 1 | COLILERT-18 | 04/03/12 | 15:07 | JW |
| Total Hardness as CaCO3 | 140 | mg/l | 2 | SM 2340 C | 04/03/12 | 12:15 | JW |

Reviewed by: Angie Woodward
A. Woodward/Technical Director

Report Date: April 18, 2012
VA LAB ID# 460019
* Subcontracted test

# ENVIRONMENTAL SYSTEMS SERVICE, LTD.

Page: 1

Work Order #: 24679
Contract #:
Customer #: 5780
Customer PO #:

MADEIRA SCHOOL
ATTN: ED HAMER
8328 GEORGETOWN PIKE
MC LEAN, VA 22102

Job Location:
Collected by: DILLON SHEADS
Date Received: 04/03/2012

## ANALYSIS REPORT

| TAG #: | SAMPLE POINT: | SAMPLE DATE: |
|---|---|---|
| 59665 | OUTFALL 001 | 04/03/2012 |

| Description | Result | Unit | Rpt. Limit | Method | Anlys Date | Time | Ini |
|---|---|---|---|---|---|---|---|
| Copper, Dissolved* | 0.0153 | mg/l | 0.0050 | EPA 200.8 | 04/07/12 | 14:07 | JRM |

Reviewed by: Angie Woodward
A. Woodward/Technical Director

Report Date: April 18, 2012
VA LAB ID# 460019
* Subcontracted test

# SAMPLE CHAIN OF CUSTODY RECORD


Company _ Environmental System Services
Contact __ Cody Hoehna
Address __ 218 North Main Street
Address __ Culpeper, Va 22701
Phone ___ 540-825-6660


## ENVIRONMENTAL SYSTEMS SERVICE, LTD.


| | | | |
|---|---|---|---|
| 218 North Main St. | 500 Stone St. | 8321 Leishear Road | 3917 Westpoint Blvd. |
| Post Office Box 520 | Post Office Box 736 | Laurel, MD 20723 | Suite E |
| Culpeper, VA 22701 | Bedford, VA 24523 | | Winston-Salem, NC 27103 |
| 800-541-2116 | 540-586-5413 | 301-617-9582 | 910-659-3378 |
| 540-825-6660 | Fax 540-586-5530 | Fax 301-617-3426 | Fax 910-659-3379 |


**Project Name/Site __ The Madeira School WER Study** P.O.#_____

**Sampled By:** Dillon Sheads (Print Name) (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | COLLECTION TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | BOD,TSS | NH3 | DOC | TOC | TR Cu | DISS Cu | E. Coli | Cond, ALK | Hardness | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59653 | 4/3/12 | 0705-1105 | Outfall 001 | 1L | P | 2 | | x | ww | None | x | | | | | | | | | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| " | | 0705-1105 | Outfall 001 | 250mL | P | 1 | | x | ww | H2SO4 | | x | | DS x | | | | | | |
| 59654 | | 1005 | Outfall 001 | 250mL | P | 2 | x | | ww | HNO3 | | | | | x | ✓ | | | | |
| 59653 | | 0705-1105 | Outfall 001 | 250mL | P | 1 | | x | ww | None | | | | | | | | x | | |
| " | | 0705-1105 | Outfall 001 | 250mL | G | 2 | | x | ww | H2SO4 | | | x | x | | | | | | |
| 59654 | ↓ | 1005 | Outfall 001 | 125mL | p | 1 | x | | ww | Na. Thios | | | | | | | x | | | |
| 59654 | 4/3/12 | 1005 | Outfall 001 | 250mL | p | 1 | x | | ww | HNO3 | | | | | | | | | x | |
| 59665 | 4/3/12 | 1005 | Outfall 001 | | | | | | | | | | | | | ✓ | | | | Preservative |
| | | | | | | | | | | | | | | | | | | | | pH Check: <2 |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

| Relinquished by: | Date | Time | Received by: |
|---|---|---|---|
| [signature] | 4/3/12 | 1155 | [signature] |
| Relinquished by: | Date | Time | Received by: |
| | | | |

| Relinquished by: | Date | Time | Received by: |
|---|---|---|---|
| [signature] | 4/3/12 | 1400 | |
| Relinquished by: | Date | Time | Received for Laboratory by: |
| | 4/3/12 | 1400 | [signature] |

Method of Delivery
☐ UPS ☐ Fed Ex ☒ Hand Delivery
☐ UPS Overnight ☐ Post Office

Remarks: ONICE
Received @ 1.4 C
☐ Under 2 hours

TAT
Normal ____ Rush ____
Need Results by _____
Extra charges will apply for Rush TAT.

W.O.# 24679
W.O.# _____

Amt Paid $_____
Check # _____

Revised 11/04/04

ESS
Environmental Systems Service, Ltd.

# Log-In / Sample Receipt Form

Customer Name: Maderra Date Received: 4-3-12

Sample Custodian:

| Tag # | Bottle # | Parameter(s) | Container size | Temp. °C | On Ice? | pH (if preserved) | Sample condition | Sample Comments |
|---|---|---|---|---|---|---|---|---|
| 59653 | 1 | BOD | 1L | 1.4 | yes | | OK | |
| | 2 | TSS | 1L | | | | | |
| | 3 | NH3 | 250 | | | <2 | | |
| | 4 | Cond, Alk | 250 | | | | | |
| | 5A,b | DOC, TOC | 250 | | | <2 | | |
| 59654 | 1 | Copper | 250 | | | <2 | | |
| | 2 | Ecoli | 125 | | | | | |
| | 3 | Hardness | 250 | | | <2 | | |
| 59665 | 1 | Copper (D) | 250 | | | <2 | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

• General Comments:

Revised5/25/07

# ENVIRONMENTAL SYSTEMS SERVICE, LTD.

Page: 1

Work Order #: 24679
Contract #:
Customer #: 5780
Customer PO #:

MADEIRA SCHOOL
ATTN: ED HAMER
8328 GEORGETOWN PIKE
MC LEAN, VA 22102

Job Location:
Collected by: DILLON SHEADS
Date Received: 04/03/2012

## ANALYSIS REPORT

COMMENT: BOD SEED CORRECTION VALUE OUTSIDE OF ACCEPTANCE RANGE.

| TAG #: | SAMPLE POINT: | SAMPLE DATE: |
|---|---|---|
| 59655 | INFLUENT | 04/03/2012 |

| Description | Result | Unit | Rpt. Limit | Method | Anlys Date | Time | Ini |
|---|---|---|---|---|---|---|---|
| Biochemical Oxygen Demand | 154 | mg/l | 2 | SM 5210 | 04/04/12 | 14:40 | AW |
| Total Suspended Solids | 113 | mg/l | 1.00 | SM 2540D | 04/05/12 | 15:59 | JI |
| Ammonia, as N | 26.6 | mg/l | 0.10 | SM 4500NH3D | 04/06/12 | 15:15 | BW |
| Hexane Extractable Material* | <5.00 | mg/l | 5.00 | EPA 1664A | 04/12/12 | 09:59 | JRM |

Reviewed by: Angie Woodward
A. Woodward/Technical Director

Report Date: April 17, 2012
VA LAB ID# 460019
* Subcontracted test

# SAMPLE CHAIN OF CUSTODY RECORD

Company _ Madeira School
Contact _____
Address _____
Address _____
Phone _____

## ENVIRONMENTAL SYSTEMS SERVICE, LTD.

ESS Environmental Systems Service, Ltd.
www.ess-services.com

218 North Main St.
Post Office Box 520
Culpeper, VA 22701
800-541-2116
540-825-6660 Fax: 540-825-4961

500 Stone St.
Post Office Box 736
Bedford, VA 24523
540-586-5413
Fax 540-586-5530

Project Name/Site WER Study P.O.# _____

Sampled By: Dillon Sheets (Print Name) (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES BOD | TSS | $NH_3$ | Hem | | E.coli | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ~~DS Effluent~~ | ~~1 L~~ | ~~P~~ | ~~2~~ | | X | ~~ww~~ | ~~None~~ | X | X | | | | | | | | |
| | | | ~~DS Effluent~~ | ~~250 ml~~ | ~~P~~ | ~~1~~ | | X | ~~ww~~ | ~~$H_2SO_4$~~ | | | X | | | | | | | |
| 59655 | 4/3/12 | 0940 | Influent | 1 L | P | 2 | X | | ww | None | X | X | | | | | | | | |
| | 4/3/12 | 0940 | Influent | 250 ml | P | 1 | X | | ww | $H_2SO_4$ | | | X | | | | | | | |
| | 4/3/12 | 0940 | Influent | 1L | G | 2 | X | | ww | $H_2SO_4$ | | | | X | | | | | | |
| | | | ~~DS Effluent~~ | ~~125ml~~ | ~~P~~ | ~~1~~ | X | | ~~ww~~ | ~~Na Thios~~ | | | | | | X | | | | Preservative |
| | | | | | | | | | | | | | | | | | | | | pH Check: <2 |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| | 4/3/12 | 1155 | | | 4/3/12 | 1400 | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | 4/3/12 | 1400 | |

Method of Delivery:
☐ UPS ☐ Fed Ex ☑ Hand Delivery
☐ UPS Overnight ☐ Post Office

On Ice? Y N
Received @ 1.4 C
☐ Under 2 hours

TAT:
Normal ____ Rush ____
Need Results by _____
Extra charges will apply for Rush TAT.

W.O.# 24679
W.O.# _____

Amt Paid $_____
Check # _____

Revised 1/18/12

ESS
Environmental Systems Service, Ltd.

# Log-In / Sample Receipt Form

Customer Name: Madeyra Date Received: 4/3/12

Sample Custodian:

| Tag # | Bottle # | Parameter(s) | Container size | Temp. °C | On Ice? | pH (if preserved) | Sample condition | Sample Comments |
|---|---|---|---|---|---|---|---|---|
| 59655 | 1 | BOD | 1L | 1.4 | yes | | OK | |
| " | 2 | TSS | 1L | " | " | | " | |
| " | 3 | NH3 | 250 | " | " | <2 | " | |
| " | 4 | Hem | 1L | " | " | <2 | " | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

General Comments:

Revised5/25/07

Madeira School WER Study APRIL 2012
Spring 2012

| Sample ID | Analyzist | Result |
|---|---|---|
| Lab Control | Copper | <0.00500 |
| 5.88 PPB Lab | Copper | 0.00560 |
| 8.40 PPB Lab | Copper | 0.00748 |
| 12.0 PPB Lab | Copper | 0.0104 |
| 17.2 PPB Lab | Copper | 0.0148 |
| 24.5 PPB Lab | Copper | 0.0194 |
| 35.0 PPB Lab | Copper | 0.0290 |
| 50.0 PPB Lab | Copper | 0.0403 |
| Site/Eff Control | Copper | 0.0148 |
| 58.8 PPB Site/Eff | Copper | 0.0652 |
| 84.0 PPB Site/Eff | Copper | 0.0846 |
| 120 PPB Site/Eff | Copper | 0.123 |
| 172 PPB Site/Eff | Copper | 0.166 |
| 245 PPB Site/Eff | Copper | 0.236 |
| 350 PPB Site/Eff | Copper | 0.313 |
| 500 PPB Site/Fff | Copper | 0.486 |
| LAB | TSS | <1.00 |
| Site/Eff | TSS | <1.00 |
| LAB | DOC | <1 |
| Site/Eff | DOC | 4.64 |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

April 13, 2012

ANGIE WOODWARD
ENVIRONMENTAL SYSTEMS SERVICE, LTD
218 N. MAIN STREET
CULPEPER, VA 22701

Purchase Order:
Client ID: THE MADEIRA SCHOOL WER STUDY
Work Order: 1010948

Dear ANGIE WOODWARD

Enclosed are the analytical results for sample(s) received by the laboratory on Friday, April 06, 2012. The signature below certifies that the results are based on the referenced methods and applicable certifications or accreditations are noted for each parameter reported (see key at end of report).

Unless otherwise specified all analyses of solid materials are based on dry weight.

Reported results relate only to the items tested, as received by the laboratory.

On-site analysis (analysis ASAP) is recommended for the following tests: pH, temperature, dissolved oxygen, residual chlorine and sulfite. When performed off-site, these tests do not meet NELAC standards.

Abbreviations:ug/L = micrograms per Liter, mg/L = milligrams per Liter, ug/g = micrograms per gram, mg/kg = milligrams per kilogram ug/wp = micrograms per wipe, ug/ml = micrograms per millimeter, uS/cm = microsiemens per centimeter at 25 degrees Celcius ppb = parts per billion, DF = Dilution Factor.

If you have any questions concerning this report, please feel free to call Client Services at 1-800-888-8061.

Sincerely,

Dawn Casto
Technical Director (or designee)

Enclosures

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

Lab ID: 1010948001 Date Received: 04/06/2012 11:00 Matrix Aqueous Liquid
Sample ID: LAB CONTROL Date Collected: 04/05/2012 15:15 Sample Type: GRAB

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | <0.00500 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 16:47 HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | **1010948002** | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | **5.88 PPB LAB** | Date Collected: | 04/05/2012 15:15 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.00560 | mg/L | 0.0050 | 1 | 04/07/2012 14:07 | JRM | 4/9/2012 16:52 | HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948003 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 8.40 PPB LAB | Date Collected: | 04/05/2012 15:15 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.00748 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 16:56 HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

Lab ID: **1010948004** Date Received: 04/06/2012 11:00 Matrix Aqueous Liquid
Sample ID: **12.0 PPB LAB** Date Collected: 04/05/2012 15:15 Sample Type: GRAB

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0104 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 17:01 HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948005 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 17.2 PPB LAB | Date Collected: | 04/05/2012 15:15 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0148 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 17:06 HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948006 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 24.5 PPB LAB | Date Collected: | 04/05/2012 15:15 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0194 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 17:31 HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | **1010948007** | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | **35.0 PPB LAB** | Date Collected: | 04/05/2012 15:15 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0290 | mg/L | 0.0050 | 1 | 04/07/2012 14:07 | JRM | 4/9/2012 17:36 | HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

Lab ID: **1010948008** Date Received: 04/06/2012 11:00 Matrix Aqueous Liquid
Sample ID: **50.0 PPB LAB** Date Collected: 04/05/2012 15:15 Sample Type: GRAB

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0403 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 17:40 HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948009 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | SITE/EFFL CONTROL | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0148 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 17:45 HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948010 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 58.8 PPB SITE/EFFL | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0652 | mg/L | 0.0050 | 1 | 04/07/2012 14:07 | JRM | 4/9/2012 17:50 | HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | **1010948011** | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | **84.0 PPB SITE/EFFL** | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0846 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 17:55 HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948012 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 120 PPB SITE/EFFL | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.123 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 18:00 HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948013 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 172 PPB SITE/EFFL | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.166 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 18:05 HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948014 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 245 PPB SITE/EFFL | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.236 | mg/L | 0.0050 | 1 | 04/07/2012 | 14:07 JRM | 4/9/2012 | 18:10 HB | | V |

Analytics Corporation
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Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948015 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 350 PPB SITE/EFFL | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.313 | mg/L | 0.0050 | 1 | 04/07/2012 14:07 | JRM | 4/9/2012 18:15 | HB | | V |



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Analytics Corporation
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Ashland, VA 23005
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Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948016 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 500 PPB SITE/EFFL | Date Collected: | 04/05/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.486 | mg/L | 0.0050 | 1 | 04/07/2012 14:07 | JRM | 4/9/2012 18:34 | HB | | V |



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Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

Lab ID: 1010948017 Date Received: 04/06/2012 11:00 Matrix Aqueous Liquid
Sample ID: LAB Date Collected: 04/05/2012 15:35 Sample Type: GRAB

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: SM 2540 D | | | | | Preparation Method: SM 2540 D | | | | | |
| Total Suspended Solids | <1.00 | mg/L | 1.00 | 1 | 04/09/2012 | 16:00 JWB | 4/10/2012 | 15:00 JWB | | V |



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Ashland, VA 23005
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Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1010948 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1010948018 | Date Received: | 04/06/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | SITE/EFFL | Date Collected: | 04/05/2012 15:35 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: SM 2540 D | | | | | Preparation Method: SM 2540 D | | | | | |
| Total Suspended Solids | <1.00 | mg/L | 1.00 | 1 | 04/09/2012 | 16:00 JWB | 4/10/2012 | 15:00 JWB | V | |

Client: Environmental Systems Service, LTD.
Project ID: ESSL1208
Client Sample ID: Madiera School Outfall 001
Permit No: VA0024120
Sample Period: 5/21/12

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# REPORT: MADIERA SCHOOL - COPPER WER (ROUND 1)

| **Submitted To:** | **Prepared By:** |
|---|---|
| Ms. Angie Woodward<br>Environmental Systems Service, LTD.<br>218 North Main Street, P.O. Box 520<br>Culpeper, VA 22701 | Coastal Bioanalysts, Inc.<br>6400 Enterprise Court<br>Gloucester, VA 23061<br>(804) 694-8285<br>www.coastalbio.com<br>Contact: Peter F. De Lisle, Technical Director |

## METHODS:

Procedures followed the previously submitted and approved study plan. Test methods are summarized below. Details regarding test conduct and data analysis are provided in attached bench sheets and printouts as applicable.

### Test Organisms

Seven days prior to testing *Ceriodaphnia dubia* cultures were started in hard synthetic freshwater (SFW; 118 mg as $CaCO_3$) using neonate cladocerans. This hardness corresponded to the anticipated approximate hardness of the effluent based on historical data. Because the hardness of the sample received for testing on 5/21/12 was 140 mg/l, animals were acclimated by renewing with water of 144 mg/l hardness the day prior to final testing on 5/23/12. Cultures were fed YCT-*Selenastrum* (@ $3.5E^7$ cells/ml) at a rate of 0.1 ml of each per 15 ml of culture solution. Production and survival of animals raised in the hard water appeared similar to that of standard lab cultures maintained in moderately hard SFW.

Test animals were < 24 h old and selected from females that had produced 3 or more broods with a minimum of 15 offspring produced by the third brood. Animals were not fed during the test but were fed YCT-*Selenastrum* approximately 5 h prior to use in tests.

### Test Solutions

Hard SFW was prepared according to the EPA recipe by dissolving ACS reagent-grade (or better) salts in high purity deionized water followed by aeration for at least 24 h. Deionized water was obtained from a Barnstead Nannopure Research Series system. The following treatment train was used for the feed water provided to the Barnstead system: well water > 10 um particle > softener > 1 um particle > activated carbon > reverse osmosis > mixed bed anion-cation exchange > 1 um particle > Barnstead Nannopure.

Effluent sample was stored at 3-4° C in the dark until used. Sample was maintained in collapsed Cubitainers with minimal headspace. Effluent was warmed to test temperature prior to use. Minimal (2.0-2.5 min) aeration was necessary to reduce oxygen to saturation concentration for range-finding and definitive tests.

A range-finding test was used to determine appropriate concentrations for use in the definitive site-water toxicity test. For the range-finding test copper was added directly to site water and then serially diluted to prepare test solutions. "Site water" consisted of 100% undiluted effluent (based on stream and plant permitted design flow. Copper was added as a 1µg/µl (1 mg/ml) stock solution prepared by dissolving 67 mg of ACS reagent-grade $CuCl_2 2H_2O$ (99.999+%; Aldrich lot #15726CH) in 25 ml high purity deionized water. The same stock was used for all tests. ). A lab-water range-finding test was not performed because sufficient historical data existed for selection of test concentrations.



VELAP# 460030
EPA# VA01116

For the definitive site water test, copper was added to the effluent (site water) and allowed to equilibrate for approximately 5 h prior to adding animals. A 2 L volume of the highest concentration of spiked effluent was prepared by adding 1000 µl of copper stock solution. Thus the final concentration was 500 µg/l (assuming no background Cu). Serial dilutions (0.7X) of spiked site water were prepared by pouring off an 600 ml aliquot of the highest concentration and bringing back to volume with un-spiked effluent. The 600 ml aliquots were added to labeled 1 L plastic beakers. The procedure was repeated to prepare seven beakers of solution of decreasing concentration. A control beaker received 600 ml of un-spiked effluent. The beakers were then allowed to stand for 3 h before being used in tests.

For the definitive lab water test 2 L of the highest concentration of hard SFW was prepared by spiking with 100 µl of copper stock solution (final concentration 50 µg/l). Serial dilutions (0.7X) of the spiked lab water were prepared as described above except using hard SFW as the diluent. The lab water solutions were then allowed to stand for approximately 5 h before being used in tests.

**Chemical Analyses**

Samples of hard SFW and effluent were collected at the beginning of the test for TSS and DOC analyses. Samples were stored at 3-4° C in the dark until shipped with copper samples for analyses. Samples (approx. 200 ml) were collected from each treatment at the beginning of the test for total Cu. Total Cu samples were poured directly into sample containers. Copper samples from both the lab and site tests, as well as TOC and DOC samples, were sent to Analytics (Ashland, VA) for analysis. All sampling supplies were provided by the chemistry lab.

Measurements of dissolved oxygen, pH, temperature, conductivity, total residual chlorine, hardness, alkalinity and ammonia were performed using EPA methods. Instruments and titrations were calibrated using standards and/or titrants traceable to NIST where applicable.

**Toxicity Tests**

Toxicity test methods followed EPA Method 2002.0 (Acute *Ceriodaphnia dubia).* Toxicity tests were conducted using 1 oz. plastic shot glasses rather than borosilicate glass to decrease adsorption of Cu to vessel walls. Six replicates of 5 animals and 25 ml of solution were tested. In addition, two dummy replicates (rather than one) were included for water quality measurements (D.O., pH, temperature, conductivity) at T=24 h and T=48 h. These "chemistry controls" were loaded with test animals in the same manner as actual test chambers. Test chambers were arranged in a randomized block design prior to addition of animals and throughout the test.

**Calculations**

Following the EPA WER guidelines (EPA, 1994) four significant figures were retained in all calculations and endpoints to prevent round-off error. EC50s were calculated using the ToxCalc (version 5.0.23) software.

EC50s for lab and site water tests were calculated using nominal and measured total Cu. Because the probit method could not be used for both sets of tests, the Trimmed Spearman-Karber method was used for all computations of measured Cu toxicity.

EC50 values were normalized to a standard (test) hardness of 144 mg/l based on the WER guidance formula (see EPA 2001.

$$EC50_{\text{Standard Hardness}} = EC50_{\text{Test Hardness}} \times (\text{Standard Hardness/Test Hardness})^{0.9422}$$

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For WER calculations, the hardness-adjusted Species Mean Acute Value (SMAV) was based on the value calculated at the criteria reference hardness (CRH, 100 mg/l) and published in the WER guidance document (24.0 µg/l total; EPA2001). The following formula (from EPA 2001) was used to normalize the SMAV value to the test standard hardness of 144 mg/l:

$$SMAV_{Test\ Hardness} = SMAV_{CRH\ (100)} \times (Test\ Hardness/100\ mg/l)^{0.9422}$$

**RESULTS:**

Table 1. EC50 values (Total Cu)

| Test Matrix | 48-h EC50 (µg/l) | 95% C.L. | Test Hardness (mg/l $CaCO_3$) | Normalized* 48-h EC50 (µg/l) |
|---|---|---|---|---|
| Lab Water: | 20.07 | 18.52-21.75 | 144 | 20.07 |
| Site Water: | 170.5 | 158.3-183.6 | 140 | 175.7 |

*Normalized to a standard hardness of 144 mg/l (as $CaCO_3$).

Table 2. Calculated WER values.

| Chemical Basis | WER Denominator Basis* | Normalized Site Water EC50 (µg/l) | Normalized Lab or SMAV EC50 (µg/l) | WER |
|---|---|---|---|---|
| Total Copper | Lab Water | 175.7 | 20.07 | 8.754 |
| | EPA 2001 | 175.7 | 33.84 | **5.192** |

*NOTE: EPA (2001) states " If the hardness-normalized EC50 in laboratory water is less than the documented SMAV for the species (i.e. EPA 2001 value), then use the SMAV in place of the laboratory water EC50 in the dominator of the WER"

Table 3. Biological and Chemical Summary Data - Lab Water Test

| Total Cu (µg/l) | | Survival (%) | |
|---|---|---|---|
| Nominal | Measured | 24-h | 48-h |
| 0* | <1 | 100 | 100 |
| 5.88 | 6.17 | 100 | 100 |
| 8.40 | 7.62 | 100 | 100 |
| 12.0 | 10.4 | 100 | 100 |
| 17.2 | 13.9 | 100 | 96.7 |
| 24.5 | 19.2 | 100 | 46.7 |
| 35.0 | 27.3 | 100 | 16.7 |
| 50.0 | 38.8 | 3.33 | 0 |

*Lab Control (hard synthetic freshwater)



VELAP# 460030
EPA# VA01116

Table 4. Biological and Chemical Summary Data – Site Water Toxicity Tests

| Total Cu (µg/l) | | | Survival (%) | |
|---|---|---|---|---|
| Nominal | Nominal + Background | Measured | 24-h | 48-h |
| 0* | 14.8 | 13.7 | 100 | 100 |
| 58.8 | 73.6 | 60.4 | 100 | 100 |
| 84.0 | 98.8 | 83.7 | 100 | 100 |
| 120 | 134.8 | 112 | 100 | 100 |
| 172 | 186.8 | 147 | 100 | 63.3 |
| 245 | 259.8 | 206 | 100 | 30.0 |
| 350 | 364.8 | 270 | 100 | 0 |
| 500 | 514.8 | 406 | 0 | 0 |

*Site Control (100% un-spiked effluent)

Table 5. Test Set-up Information

| Test Matrix | Definitive Test Start Date/Time End Date/Time | Organism Source | Brood Release Date/Time | Acclimation Temp. | Acclimation Water | Test Aerated? |
|---|---|---|---|---|---|---|
| Lab Water | 5/23/12 1550<br>5/25/12 1600 | CBI Stock | 5/22/12 1730<br>5/23/12 1230 | 25° C | Hard SFW | No |
| Site Water | 5/23/12 1615<br>5/25/12 1615 | CBI Stock | 5/22/12 1730<br>5/23/12 1230 | 25° C | Hard SFW | No |

Table 6. Lab and Effluent Water Quality Data

| Water Quality Parameter (Units) | Lab Water | Effluent |
|---|---|---|
| Arrival Temperature (°C) | N/A | 1 |
| Use Temperature (°C) | 25 | 25 |
| Conductivity (µS/cm) | 524 | 844 |
| pH (S.U.) | 7.92 | 8.00 |
| Dissolved Oxygen (mg/l) | 8.2 | 8.2 |
| Total Hardness (mg/l as $CaCO_3$) | 144 | 140 |
| Alkalinity (mg/l as $CaCO_3$) | 78 | 175 |
| DOC (mg/l) | <1.0 | 6.28 |
| TSS (mg/l) | <1.0 | <1.0 |
| Total Residual Chlorine (mg/l) | N/A | <Q.L. |
| Ammonia (mg/l $NH_3$-N) | <1.0 | <1.0 |

Table 7. Sample Aging/Use/Pretreatment

| CBI Sample I.D. | Collection Date/Time | Date(s)/Time(s) Used in Range Tests | Date(s)/Time(s) Used in Definitive Tests | Sample Adjustments |
|---|---|---|---|---|
| ESSL1208-A | 5/21/12 1300 | 5/21/12 1715 | 5/23/12 1550 (lab), 1615 (site) | Aerated 2-2.5 min |

Table 8. Lab Water Test - Water Quality (Mean/Std. Dev.)

| Nominal Cu (µg/l): | Cont. | 5.88 | 8.40 | 12.0 | 17.2 | 24.5 | 35.0 | 50.0 |
|---|---|---|---|---|---|---|---|---|
| Temp. (°C) | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 |
| D.O. (mg/l) | 7.9<br>0.3 | 7.9<br>0.2 | 7.9<br>0.3 | 7.9<br>0.3 | 7.9<br>0.3 | 7.9<br>0.3 | 7.9<br>0.3 | 8.0<br>0.2 |
| PH (S.U.) | 7.97<br>0.07 | 7.98<br>0.06 | 7.97<br>0.07 | 7.97<br>0.07 | 7.97<br>0.07 | 7.98<br>0.06 | 7.98<br>0.07 | 7.98<br>0.07 |

Table 9. Site Water Test - Water Quality (Mean/Std. Dev.)

| Nominal Cu (µg/l): | Cont. | 58.8 | 84.0 | 120 | 172 | 245 | 350 | 500 |
|---|---|---|---|---|---|---|---|---|
| Temp. (°C) | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 | 25<br>0 |
| D.O. (mg/l) | 8.0<br>0.2 | 8.0<br>0.2 | 7.9<br>0.2 | 7.9<br>0.2 | 7.9<br>0.2 | 7.9<br>0.2 | 8.0<br>0.2 | 8.1<br>0.1 |
| PH (S.U.) | 8.14<br>0.04 | 8.14<br>0.05 | 8.14<br>0.04 | 8.15<br>0.04 | 8.15<br>0.03 | 8.15<br>0.04 | 8.15<br>0.03 | 8.17<br>0.03 |

Table 10. Reference Toxicant Test Data
(Reference Toxicant: KCl; Units: mg/l; CBI Stock Cultures)

| Species-Method (Ref. Test Date) | Data Source | % Control Survival | 48-h EC50 | 95% C.L./A.L. For EC50 | RTT in Control? |
|---|---|---|---|---|---|
| *C. dubia* 2002.0 | RTT | 100 | 503 | 466-544 | Yes |
| (5/25/12-5/27/12) | CC | 98 | 592 | 514-670 | |

Note: RTT = Reference Toxicant Test, CC = Control Chart.

**DISCUSSION:**

A WER value of 5.192 is obtained based on the ratio of the site EC50 to the hardness-adjusted SMAV in this study. Based on the geometric mean of this value and the value obtained in the April 2012 study (6.921), **the final WER value is 5.994.**

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**LITERATURE CITED:**

EPA 1994. *Interim Guidance on Determination and Use of Water-effects Ratios for Metals.* February 1994. EPA-823-B-94-001.

EPA 2001. Streamlined Water-Effect Ratio Procedure for Discharges of Copper. EPA-822-R-01-005. United States Environmental Protection Agency, Office of Water, March 2001.

**GLOSSARY OF TERMS AND ABBREVIATIONS:**

**A.L. (Acceptance Limits):** The results of a given reference toxicant test are compared to the control chart mean value ± 2 standard deviations. These limits approximate the 95% probability limits for the "true" reference toxicant value.

**C.L. (Confidence Limits):** These are the probability limits, based on the data set and statistical model employed, that the "true value" lies within the limits specified. Typically limits are based on 95% or 99% probabilities.

**Control chart:** A cumulative summary chart of results from QC tests with reference toxicants. The results of a given reference toxicant test are compared to the control chart mean value and 95% Acceptance Limits (A.L.) (mean ± 2 standard deviations).

**EC50/LC50:** The concentration of sample or chemical, calculated from the data set using statistical models, causing a 50% reduction in test organism survival or mobilization. The lower the EC50/ LC50, the more toxic the chemical or sample. Units are same as test concentration units. Note: The LC50 or EC50 value must always be associated with the duration of exposure.

**N/A:** Not applicable. **N/D:** Not determined or measured.

**Q.L.:** Quantitation Limit. Level, concentration, or quantity of a target variable (analyte) that can be reported at a specified degree of confidence.

**Species Mean Acute Value (SMAV):** Mean value of hardness-normalized EC50 values. Used in the criteria document for calculation of water quality criteria.

**Water-Effect Ratio (WER):** A criteria adjustment factor accounting for the effect of site-specific water characteristics on pollutant bioavailability and toxicity to aquatic life (from EPA 2001).

Client: Environmental Systems Service, LTD.
Project ID: ESSL1208
Client Sample ID: Madiera School Outfall 001
Permit No: VA0024120
Sample Period: 5/21/12

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The results of analysis contained within this report relate only to the sample as received in the laboratory. This report shall not be reproduced except in full without written approval from the laboratory. Unless noted below, these test results meet all requirements of NELAP.

APPROVED:

Peter F. De Lisle, Ph.D.
Technical Director

6/12/12
Date

Deviations from, additions to, or exclusions from the test method, non-standard conditions or data qualifiers and, as appropriate, a statement of compliance/non-compliance: **NONE**



VELAP# 460030
EPA# VA01116

NELAP ACCREDITED LABORATORY

*CERIODAPHNIA DUBIA* STATIC ACUTE TEST - WER
FORM ETF1051WER

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 5/21/12

| Parameter | Treatment I.D. | Day 0 | Day 1 | Day 2 |
|---|---|---|---|---|
| Temp. (°C) | C | 25 | 25 | 25 |
| | 1 | 25 | 25 | 25 |
| | 2 | 25 | 25 | 25 |
| | 3 | 25 | 25 | 25 |
| | 4 | 25 | 25 | 25 |
| | 5 | 25 | 25 | 25 |
| | 6 | 25 | 25 | 25 |
| | 7 | 25 | 25 | 25 |
| pH (S.U.) | C | 8.05 | 7.96 | 7.91 |
| | 1 | 8.04 | 7.97 | 7.93 |
| | 2 | 8.04 | 7.97 | 7.90 |
| | 3 | 8.04 | 7.97 | 7.96 |
| | 4 | 8.04 | 7.97 | 7.91 |
| | 5 | 8.04 | 7.97 | 7.92 |
| | 6 | 8.05 | 7.97 | 7.92 |
| | 7 | 8.05 | 7.97 | 7.91 |
| D.O. (mg/l) | C | 8.2 | 7.8 | 7.7 |
| | 1 | 8.2 | 7.8 | 7.8 |
| | 2 | 8.2 | 7.8 | 7.7 |
| | 3 | 8.2 | 7.8 | 7.7 |
| | 4 | 8.2 | 7.8 | 7.7 |
| | 5 | 8.2 | 7.9 | 7.7 |
| | 6 | 8.2 | 7.9 | 7.7 |
| | 7 | 8.2 | 7.9 | 7.8 |
| Conduct. (Us/cm) | C | 519 | | 521 |
| | 1 | 521 | | |
| | 2 | 521 | | |
| | 3 | 521 | | |
| | 4 | 521 | | |
| | 5 | 520 | | |
| | 6 | 520 | | |
| | 7 | 520 | | 526 |
| Replicate Meas.: | | S | S | S |
| Initials: | | GB | PB | PB |
| TRC (mg/l) in highest conc. at end of test: | | | | NA |

**Species:** *Ceriodaphnia dubia*

**Source:** CBI stock cultures ✓

Other: _____

**Brood Release:** Date/time start: 5/22/12 1730

Date /time end: 5/23/12 1230

**Acclimation:** Water: Mod. hard syn. FW ___

Other 118-144 mg/L bead SCW

Temperature (°C): 25

**Feeding:** Prior to test: YCT/*Selenastrum*
During test: Not Fed

**Illumination:** 16L:8D 10-20 uE/m$^2$/s

**Test chamber size:** ✓ 30 ml

**Solution volume:** ✓ 15 ml _____ ml

**Number of replicates/treatment:** 6

**Initial number of daphnids/replicate:** 5

**Template number:** NA

**Set up:** Date (Day 0): 5/23/12

Time water added: 1005

Time daphnids added: 1550

Set up by (initials): GB

 Test ID: E55L1208 ACD-WER Site Water ___ Lab Water ✓

*CERIODAPHNIA DUBIA* STATIC ACUTE TEST - WER
FORM ETF1051WER

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 5/21/12

| Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| Control | C-a | 5 | 5 | 5 | 100 |
| | C-b | 5 | 5 | 5 | |
| | C-c | 5 | 5 | 5 | |
| | C-d | 5 | 5 | 5 | |
| | C-e | 5 | 5 | 5 | |
| | C-f | 5 | 5 | 5 | |
| 5.88 | 1-a | 5 | 5 | 5 | 100 |
| | 1-b | 5 | 5 | 5 | |
| | 1-c | 5 | 5 | 5 | |
| | 1-d | 5 | 5 | 5 | |
| | 1-e | 5 | 5 | 5 | |
| | 1-f | 5 | 5 | 5 | |
| 8.40 | 2-a | 5 | 5 | 5 | 100 |
| | 2-b | 5 | 5 | 5 | |
| | 2-c | 5 | 5 | 5 | |
| | 2-d | 5 | 5 | 5 | |
| | 2-e | 5 | 5 | 5 | |
| | 2-f | 5 | 5 | 5 | |
| 12.0 | 3-a | 5 | 5 | 5 | 100 |
| | 3-b | 5 | 5 | 5 | |
| | 3-c | 5 | 5 | 5 | |
| | 3-d | 5 | 5 | 5 | |
| | 3-e | 5 | 5 | 5 | |
| | 3-f | 5 | 5 | 5 | |

| Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| 17.2 | 4-a | 5 | 5 | 4 | 97 |
| | 4-b | 5 | 5 | 5 | |
| | 4-c | 5 | 5 | 5 | |
| | 4-d | 5 | 5 | 5 | |
| | 4-e | 5 | 5 | 5 | |
| | 4-f | 5 | 5 | 5 | |
| 24.5 | 5-a | 5 | 5 | 3 | 47 |
| | 5-b | 5 | 5 | 2 | |
| | 5-c | 5 | 5 | 1 | |
| | 5-d | 5 | 5 | 4 | |
| | 5-e | 5 | 5 | 2 | |
| | 5-f | 5 | 5 | 2 | |
| 35.0 | 6-a | 5 | 5 | 0 | 17 |
| | 6-b | 5 | 5 | 0 | |
| | 6-c | 5 | 5 | 1 | |
| | 6-d | 5 | 5 | 2 | |
| | 6-e | 5 | 5 | 0 | |
| | 6-f | 5 | 5 | 2 | |
| 50.0 | 7-a | 5 | Ø | 0 | 0 |
| | 7-b | 5 | 0 | 0 | |
| | 7-c | 5 | 0 | 0 | |
| | 7-d | 5 | 0 | 0 | |
| | 7-e | 5 | 0 | 0 | |
| | 7-f | 5 | Ø? | 0 | |
| | Initials: | GB | PS | PS | |
| | Count Time: | 1550 | 1015 | 1600 | Test end time |

① 5/23/12 GB
② 5/24/12 PS

Highest concentration = 100 µl stock in 2000 ml

Dilution factor = 0.7 X (2000 ml highest conc.; pour off 600 ml for each dilution)

Peer Rev by: PS/AG Date: 6/8/12

 Test ID: ESSC1208 ACD-WER Site Water ___ Lab Water ✓

## Acute Ceriodaphnia Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/23/2012 15:50 | Test ID: | ESSL1208LN | Sample ID: | MADIERA SCHOOL 001 WER STUDY |
| End Date: | 5/25/2012 16:00 | Lab ID: | CBI | Sample Type: | NOMINAL CU |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

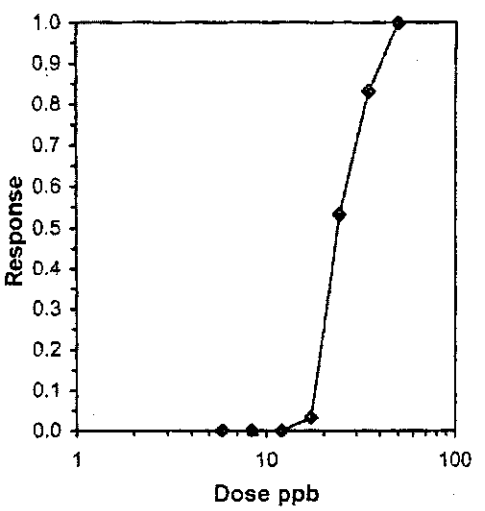
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 5.88 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 8.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 17.2 | 0.8000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 24.5 | 0.6000 | 0.4000 | 0.2000 | 0.8000 | 0.4000 | 0.4000 |
| 35 | 0.0000 | 0.0000 | 0.2000 | 0.4000 | 0.0000 | 0.4000 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 5.88 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 8.4 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 12 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 17.2 | 0.9667 | 0.9667 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 24.5 | 0.4667 | 0.4667 | 0.7518 | 0.4636 | 1.1071 | 29.191 | 6 | 16 | 30 |
| 35 | 0.1667 | 0.1667 | 0.4183 | 0.2255 | 0.6847 | 54.046 | 6 | 25 | 30 |
| 50 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.79399 | 0.922 | 0.52623 | 3.03339 |
| Equality of variance cannot be confirmed | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 25.409 | 23.357 | 27.641 |
| 5.0% | 25.247 | 23.092 | 27.603 |
| 10.0% | 24.983 | 22.719 | 27.472 |
| 20.0% | 24.621 | 21.883 | 27.702 |
| Auto-0.0% | 25.409 | 23.357 | 27.641 |






ToxCalc v5.0.23

Reviewed by: JD

## Acute Fish Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/23/2012 15:50 | Test ID: | ESSL1208L | Sample ID: | MADIERA SCHOOL 001 WER STUDY |
| End Date: | 5/25/2012 16:00 | Lab ID: | CBI | Sample Type: | MEASURED CU/LAB WATER |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

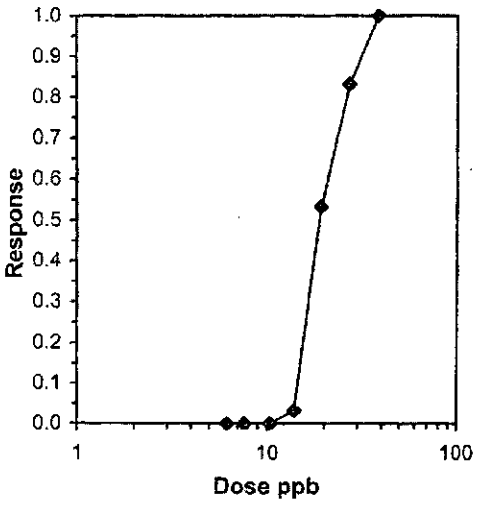
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6.17 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 7.62 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 10.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 13.9 | 0.8000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 19.2 | 0.6000 | 0.4000 | 0.2000 | 0.8000 | 0.4000 | 0.4000 |
| 27.3 | 0.0000 | 0.0000 | 0.2000 | 0.4000 | 0.0000 | 0.4000 |
| 38.8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 6.17 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 7.62 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 10.4 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 13.9 | 0.9667 | 0.9667 | 1.3056 | 1.1071 | 1.3453 | 7.446 | 6 | 1 | 30 |
| 19.2 | 0.4667 | 0.4667 | 0.7518 | 0.4636 | 1.1071 | 29.191 | 6 | 16 | 30 |
| 27.3 | 0.1667 | 0.1667 | 0.4183 | 0.2255 | 0.6847 | 54.046 | 6 | 25 | 30 |
| 38.8 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.79399 | 0.922 | 0.52623 | 3.03339 |
| Equality of variance cannot be confirmed | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 20.072 | 18.520 | 21.753 |
| 5.0% | 19.912 | 18.274 | 21.696 |
| 10.0% | 19.693 | 17.977 | 21.573 |
| 20.0% | 19.387 | 17.332 | 21.687 |
| Auto-0.0% | 20.072 | 18.520 | 21.753 ✓ |



*CERIODAPHNIA DUBIA* STATIC ACUTE TEST - WER
FORM ETF1051WER

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 5/21/12

| Parameter | Treatment I.D. | Day 0 | Day 1 | Day 2 |
|---|---|---|---|---|
| Temp. (°C) | C | 25 | 25 | 25 |
| | 1 | 25 | 25 | 25 |
| | 2 | 25 | 25 | 25 |
| | 3 | 25 | 25 | 25 |
| | 4 | 25 | 25 | 25 |
| | 5 | 25 | 25 | 25 |
| | 6 | 25 | 25 | 25 |
| | 7 | 25 | 25 | — |
| pH (S.U.) | C | 8.18 | 8.14 | 8.11 |
| | 1 | 8.18 | 8.15 | 8.09 |
| | 2 | 8.18 | 8.15 | 8.10 |
| | 3 | 8.18 | 8.15 | 8.11 |
| | 4 | 8.18 | 8.15 | 8.12 |
| | 5 | 8.18 | 8.15 | 8.11 |
| | 6 | 8.18 | 8.15 | 8.13 |
| | 7 | 8.19 | 8.15 | — |
| D.O. (mg/l) | C | 8.2 | 7.9 | 7.8 |
| | 1 | 8.2 | 7.9 | 7.8 |
| | 2 | 8.2 | 7.8 | 7.8 |
| | 3 | 8.2 | 7.8 | 7.8 |
| | 4 | 8.2 | 7.8 | 7.8 |
| | 5 | 8.2 | 7.8 | 7.8 |
| | 6 | 8.2 | 7.9 | 7.8 |
| | 7 | 8.2 | 8.0 | — |
| Conduct. (Us/cm) | C | 842 | | 850 |
| | 1 | 845 | | |
| | 2 | 845 | | |
| | 3 | 846 | | |
| | 4 | 848 | | |
| | 5 | 848 | | |
| | 6 | 850 | | 853 |
| | 7 | 851 | | — |
| Replicate Meas.: | | S | S | S |
| Initials: | | GB | PB | PD |
| TRC (mg/l) in highest conc. at end of test: | | | | NA |

**Species:** *Ceriodaphnia dubia*

**Source:** CBI stock cultures ✓

Other: _____

**Brood Release:** Date/time start: 5/22/12 1730

Date /time end: 5/23/12 1230

**Acclimation:** **Water:** Mod. hard syn. FW ____

Other 118-144 mg/L HARD SYN FW

**Temperature (°C):** 25

**Feeding:** **Prior to test:** YCT/*Selenastrum*
**During test:** Not Fed

**Illumination:** 16L:8D 10-20 uE/m$^2$/s

**Test chamber size:** ✓ 30 ml

**Solution volume:** ✓ 15 ml _____ ml

**Number of replicates/treatment:** 6

**Initial number of daphnids/replicate:** 5

**Template number:** NA

**Set up:** **Date (Day 0):** 5/23/12

**Time water added:** 1020

**Time daphnids added:** 1615

**Set up by (initials):** GB

 Test ID: ESSL 1208 ACD-WER Site Water ✓ Lab Water ____

*CERIODAPHNIA DUBIA* STATIC ACUTE TEST - WER
FORM ETF1051WER

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 5/21/12

| Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival | Nominal Cu (µg/l) | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Control | C-a | 5 | 5 | 5 | 100 | 172 | 4-a | 5 | 5 | 3 | 63 |
| | C-b | 5 | 5 | 5 | | | 4-b | 5 | 5 | 4 | |
| | C-c | 5 | 5 | 5 | | | 4-c | 5 | 5 | 3 | |
| | C-d | 5 | 5 | 5 | | | 4-d | 5 | 5 | 4 | |
| | C-e | 5 | 5 | 5 | | | 4-e | 5 | 5 | 2 | |
| | C-f | 5 | 5 | 5 | | | 4-f | 5 | 5 | 3 | |
| 58.8 | 1-a | 5 | 5 | 5 | 100 | 245 | 5-a | 5 | 5 | 1 | 30 |
| | 1-b | 5 | 5 | 5 | | | 5-b | 5 | 5 | 5 | |
| | 1-c | 5 | 5 | 5 | | | 5-c | 5 | 5 | 1 | |
| | 1-d | 5 | 5 | 5 | | | 5-d | 5 | 5 | 1 | |
| | 1-e | 5 | 5 | 5 | | | 5-e | 5 | 5 | 1 | |
| | 1-f | 5 | 5 | 5 | | | 5-f | 5 | 5 | 0 | |
| 84.0 | 2-a | 5 | 5 | 5 | 100 | 350 | 6-a | 5 | 5 | 0 | 0 |
| | 2-b | 5 | 5 | 5 | | | 6-b | 5 | 5 | 0 | |
| | 2-c | 5 | 5 | 5 | | | 6-c | 5 | 5 | 0 | |
| | 2-d | 5 | 5 | 5 | | | 6-d | 5 | 5 | 0 | |
| | 2-e | 5 | 5 | 5 | | | 6-e | 5 | 5 | 0 | |
| | 2-f | 5 | 5 | 5 | | | 6-f | 5 | 5 | 0 | |
| 120 | 3-a | 5 | 5 | 5 | 100 | 500 | 7-a | 5 | 0 | - | 0 |
| | 3-b | 5 | 5 | 5 | | | 7-b | 5 | 0 | - | |
| | 3-c | 5 | 5 | 5 | | | 7-c | 5 | 0 | - | |
| | 3-d | 5 | 5 | 5 | | | 7-d | 5 | 0 | - | |
| | 3-e | 5 | 5 | 5 | | | 7-e | 5 | 0 | - | |
| | 3-f | 5 | 5 | 5 | | | 7-f | 5 | 0 | - | |
| | | | | | | Initials: | | CB | PB | PB | |
| | | | | | | Count Time: | | 1615 | 1025 | 1615 | *Test end time |

Highest concentration = 1000 µl stock in 2000 ml

Dilution factor = 0.7 X ( 2000 ml highest conc.; pour off 600 ml for each dilution)

Peer Rev by: PB/AG Date: 6/8/12

 Test ID: ESSL1208 ACD-WER Site Water ✓ Lab Water ____

## Acute Ceriodaphnia Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/23/2012 16:15 | Test ID: | ESSL1208SN | Sample ID: | ~~MADIERA~~ SCHOOL 001 WER STUDY |
| End Date: | 5/25/2012 16:15 | Lab ID: | CBI | Sample Type: | NOMINAL CU |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | ~~CD-~~Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

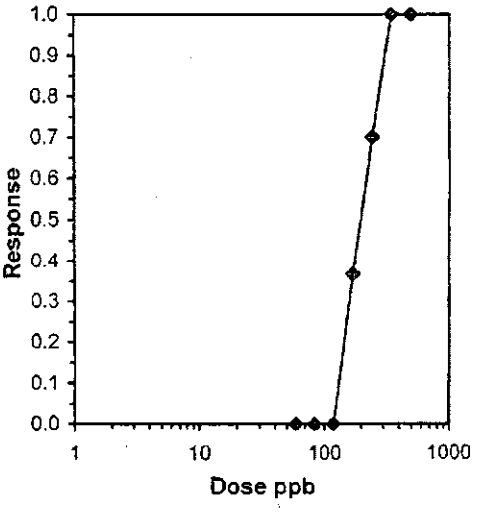
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 58.8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 84 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 120 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 172 | 0.6000 | 0.8000 | 0.6000 | 0.8000 | 0.4000 | 0.6000 |
| 245 | 0.2000 | 1.0000 | 0.2000 | 0.2000 | 0.2000 | 0.0000 |
| 350 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 500 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 58.8 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 84 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 120 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 172 | 0.6333 | 0.6333 | 0.9262 | 0.6847 | 1.1071 | 17.317 | 6 | 11 | 30 |
| 245 | 0.3000 | 0.3000 | 0.5709 | 0.2255 | 1.3453 | 68.514 | 6 | 21 | 30 |
| 350 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |
| 500 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.58168 | 0.912 | 3.08347 | 16.4935 |
| Equality of variance cannot be confirmed | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | |
|---|---|---|---|
| 0.0% | 200.35 | 183.76 | 218.45 |
| 5.0% | 199.91 | 181.80 | 219.82 |
| 10.0% | 199.48 | 179.94 | 221.15 |
| 20.0% | 198.72 | 176.67 | 223.53 |
| Auto-0.0% | 200.35 | 183.76 | 218.45 ✓ |



## Acute Fish Test-48 Hr Survival

| | | | | | |
|---|---|---|---|---|---|
| Start Date: | 5/23/2012 16:15 | Test ID: | ESSL1208S | Sample ID: | MADIERA SCHOOL 001 WER STUDY |
| End Date: | 5/25/2012 16:15 | Lab ID: | CBI | Sample Type: | MEASURED CU/SITE WATER |
| Sample Date: | | Protocol: | EPAA 91-EPA Acute | Test Species: | CD-Ceriodaphnia dubia |
| Comments: | DATA ENTERED BY PB | | | | |

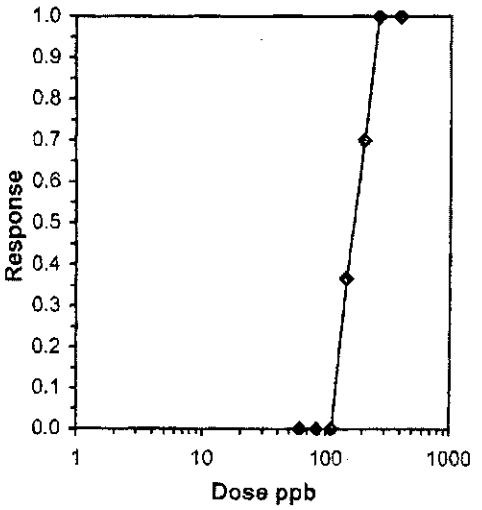
| Conc-ppb | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| CONTROL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 60.4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 83.7 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 112 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 147 | 0.6000 | 0.8000 | 0.6000 | 0.8000 | 0.4000 | 0.6000 |
| 206 | 0.2000 | 1.0000 | 0.2000 | 0.2000 | 0.2000 | 0.0000 |
| 270 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 406 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | Transform: Arcsin Square Root | | | | | Number | Total |
|---|---|---|---|---|---|---|---|---|---|
| Conc-ppb | Mean | N-Mean | Mean | Min | Max | CV% | N | Resp | Number |
| CONTROL | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 60.4 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 83.7 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 112 | 1.0000 | 1.0000 | 1.3453 | 1.3453 | 1.3453 | 0.000 | 6 | 0 | 30 |
| 147 | 0.6333 | 0.6333 | 0.9262 | 0.6847 | 1.1071 | 17.317 | 6 | 11 | 30 |
| 206 | 0.3000 | 0.3000 | 0.5709 | 0.2255 | 1.3453 | 68.514 | 6 | 21 | 30 |
| 270 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |
| 406 | 0.0000 | 0.0000 | 0.2255 | 0.2255 | 0.2255 | 0.000 | 6 | 30 | 30 |

| Auxiliary Tests | Statistic | Critical | Skew | Kurt |
|---|---|---|---|---|
| Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01) | 0.58168 | 0.912 | 3.08347 | 16.4935 |
| Equality of variance cannot be confirmed | | | | |

### Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | | |
|---|---|---|---|---|
| 0.0% | 170.48 | 158.34 | 183.56 | |
| 5.0% | 170.15 | 156.86 | 184.55 | |
| 10.0% | 169.81 | 155.41 | 185.54 | |
| 20.0% | 169.14 | 152.57 | 187.52 | |
| Auto-0.0% | 170.48 | 158.34 | 183.56 | ✓ |






ToxCalc v5.0.23

Reviewed by: PO

*CERIODAPNIA DUBIA* WER RANGE-FINDING TEST
FORM ETF1051WER RFT

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 5/21/12

**Lab Water RFT**

| Nominal Cu ug/l | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| Lab Control | C-A | | | | |
| | C-B | | | | |
| | 1-A | | | | |
| | 1-B | | | | |
| | 2-A | | | | |
| | 2-B | | | | |
| | 3-A | | | | |
| | 3-B | | | | |
| | 4-A | | | | |
| | 4-B | | | | |
| | 5-A | | | | |
| | 5-B | | | | |
| | 6-A | | | | |
| | 6-B | | | | |
| | 7-A | | | | |
| | 7-B | | | | |
| Initials: | | | | | |
| Count Time: | | | | | |

NA SURFACTANTS HOPKINS DATA.

*Test End Time

**Site Water RFT**

| Nominal Cu ug/l | I.D. | Day 0 Live | Day 1 Live | Day 2 Live | Final % Survival |
|---|---|---|---|---|---|
| Site Control | S-A | 5 | 5 | 5 | 100 |
| | S-B | 5 | 5 | 5 | |
| 12.5 | 1-A | 5 | 5 | 5 | 100 |
| | 1-B | 5 | 5 | 5 | |
| 25 | 2-A | 5 | 5 | 5 | 100 |
| | 2-B | 5 | 5 | 5 | |
| 50 | 3-A | 5 | 5 | 5 | 100 |
| | 3-B | 5 | 5 | 5 | |
| 100 | 4-A | 5 | 5 | 5 | 100 |
| | 4-B | 5 | 5 | 5 | |
| 200 | 5-A | 5 | 5 | 5 | 100 |
| | 5-B | 5 | 5 | 5 | |
| 400 | 6-A | 5 | 3 | 0 | 0 |
| | 6-B | 5 | 0 | 0 | |
| 800 | 7-A | 5 | 0 | 0 | 0 |
| | 7-B | 5 | 0 | 0 | |
| Initials: | | GB | GB | GB | |
| Count Time: | | 1715 | 0925 | 0830 | |

*Test End Time

**Species:** *Ceriodaphnia dubia*

**Source:** **CBI stock cultures** ✓

**Other:** _____

**Brood Release:** **Date/time start:** 5/20/12 1800

**Date /time end:** 5/21/12 1630

**Acclimation:** **Water:** Mod. hard syn. FW ✓

Other _____

**Temperature (°C):** 25

**Feeding:** **Prior to test:** YCT/*Selenastrum*
**During test:** Not Fed

**Illumination:** 16L:8D 10-20 uE/m²/s

**Test chamber size:** ✓ **30 ml**

**Solution volume:** ✓ **15 ml** _____ **ml**

**Number of replicates/treatment: 2**

**Initial number of daphnids/replicate: 5**

**Template number:** NA

**Set up:** **Date (Day 0):** 5/21/12

**Time water added:** 1650

**Time daphnids added:** 1715

**Set up by (initials):** GB

| End of Test Water Qual. | Lab Water | | Site Water | |
|---|---|---|---|---|
| | Control | Mort* | Control | Mort |
| Temp (°C) | | | 25 | 25 |
| pH | | | 8.00 | 8.09 |
| D.O. (mg/l) | | | 7.9 | 7.9 |
| Cond. (uS) | | | 840 | 848 |

*Mort=Lowest concentration with 100% mortality at end of test

**Lab Water RFT:**

Highest conc. = _____ µl stock in _____ ml

**Site Water RFT:**

Highest conc. = 80 µl stock in 100 ml

Peer Rev. by: RD Date: 5/25/12

ESSL 1208
TEST I.D.(Date) 05-2112 WER-RFT

EFFLUENT, STREAM & DILUTION WATER CHARACTERISTICS
FORM ETF2031WER

COASTAL BIOANALYSTS, INC
EFFECTIVE DATE: 5/21/12

| INITIAL SAMPLE CHARACTERIZATION[1] | | | |
|---|---|---|---|
| Source | Effluent | Stream | Site |
| Tot. Res. Chlorine (mg/l) | <QL | NA | NA |
| Hardness (mg/l $CaCO_3$) | 140 | | |
| Alkalinity (mg/l $CaCO_3$) | 125 | | |
| $NH_3$-N (mg/l) | <1.0 | | |
| Color/Appearance[2] | CY | | |
| Obvious Odor? | No | | |
| Date/Initials | 5/21 GB | | |

| DILUTION WATER CHARACTERISTICS | | |
|---|---|---|
| Test | Range-finding ① | Definitive |
| Temperature (°C) | 25 | 25 |
| Conductivity (uS/cm) | 348 | 524 |
| D.O. (mg/l) | 8.2 | 8.2 |
| pH (S.U.) | 7.88 | 7.92 |
| Hardness (mg/l $CaCO_3$) | 120 | 144 |
| Alkalinity (mg/l $CaCO_3$) | 67 | 78 |
| $NH_3$-N (mg/l) | <1.0 | <1.0 |
| Date/Initials | 5/21 GB | 5/23 GB |

| SAMPLE PREPARATION MEASUREMENTS (100% concentration) | | | |
|---|---|---|---|
| Test | Range-finding | Definitive | |
| Source | Site (Mix) Effluent 100% | Effluent | Stream |
| Prep Temperature (°C) | 25 | 25 | NA |
| Conductivity (uS/cm) | 845 | 844 | |
| D.O. (mg/l) After Warming | 9.5 | 10.0 | |
| Aeration Time (min) | 2.0 | 2.5 | |
| Adjusted D.O. | 8.2 | 8.2 | |
| Final pH (S.U.) | 8.09 | 8.00 | |
| Tot. Res. Chlorine (mg/l)[3] | N.D. | N.D. | |
| Sample Filtered (60 um)? | No | No | |
| Date/Time | 5/21 1640 | 5/22 0920 | |
| Initials | GB | GB | |

Toxicant: $CuCl_2 \cdot 2H_2O$
"A" Bottle # 328
Bal. Calib. Chk: 100 mg wt: 10.00 / 00.00
Stock = 67 mg/ 25 ml
Prepared by: GB Date: 4/2/12

B Stock
B154

① Not used.

*As total compound. As toxic component = Cu mg/ml

Preparation of test solutions (definitive test)

| Test Procedure | Site water | Lab Water |
|---|---|---|
| Dilution factor: | 0.7 X | 0.7 X |
| Volume diluted spiked effluent or SFW added to each conc. prep flask: | 600 ml | 600 ml |
| Time diluted spiked effluent or SFW added: | 1020 | 1005 |
| Volume stream water added to each flask of spiked effluent: | NA | |
| Time stream water added to each flask of spiked effluent: | NA | |

NOTES:

[1]Q.L. = Quantification Limit, N.D. = Not Determined/Measured, NA = Not Applicable
[2]C-Clear, O-Opaque, T-Turbid, S-Solids (Sl-Slight, M-Moderate, H-Heavy), Y-Yellow, B-Brown, Bl-Black, G-Green
[3]Total residual chlorine measured after sample prep only if present in initial sample characterization

Peer Rev by PB Date 6/8/12 PROJECT I.D. ESSL1208 WER
(First 8 characters of Laboratory Sample ID)

ESSL1208A 12-0420

ESS WO # _____

ESS PO # _____

# BIOASSAY CHAIN OF CUSTODY

Customer Madeira WER Study VPDES Permit # VA 0024121

Outfall/Location Outfall 001

## SAMPLE INFORMATION

**GRAB**

Collection: Date _____ Time _____

Sample volume _____ Flow rate _____

Effluent: pH (SU) _____ Temp (°C) _____ Chlorine (mg/l) _____

Dissolved $O_2$ (mg/l) _____ Conductivity (indicate unit) _____

Analysis (Date/Time) _____

**COMPOSITE**

Collection: From (Date/Time): 5/21/12 0900 To (Date/Time): 5/21/12 1300

# of samples 5 (4HC) Volume 5gal Flow rate 21-23 gpm

Auto-sampler temperature (°C) 0.°C (REF)

Effluent: pH (SU) 7.89 Temp (°C) 20.5 Chlorine (mg/l) n/a

Dissolved $O_2$ (mg/l) 8.91

Analysis (Date/Time) 5/21/12 0914

Sampler's Signature _____

Received at ESS Lab by: _____ Date _____ Time _____

Delivery method to Bioassay Lab: _____ Coolant used: _____

Received at Coastal Lab by: B. B. Date 5/21/12 Time 1620

Temperature of sample upon receipt @ Coastal Lab: 1

| | | |
|---|---|---|
| ___ | Chronic | *Ceriodaphnia dubia* |
| ___ | Chronic | *Pimephales promelas* |
| ___ | Acute | *Ceriodaphnia dubia* |
| ___ | Acute | *Pimephales promelas* |

# SAMPLE CHAIN OF CUSTODY RECORD


**Company** Environmental System Services
**Contact** Cody Hoehna
**Address** 218 North Main Street
**Address** Culpeper, Va 22701
**Phone** 540-825-6660


## ENVIRONMENTAL SYSTEMS SERVICE, LTD.


218 North Main St.
Post Office Box 520
Culpeper, VA 22701
800-541-2116
540-825-6660

500 Stone St.
Post Office Box 736
Bedford, VA 24523
540-586-5413
Fax 540-586-5530


**Project Name/Site** The Madeira School WER Study **P.O.#**

**Sampled By:** Geoff Briggs (Print Name) (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES TR Cu | TSS | DOC | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5/23 | 1530 | 172ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| | 5/23 | 1530 | 245ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| | 5/23 | 1530 | 350 ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| | 5/23 | 1530 | 500 ppb site/eff1 | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| | 5/23 | 1510 | lab | 1L | P | 1 | x | | ww | None | | x | | |
| | 5/23 | 1510 | site/eff1 | 1L | P | 1 | x | | ww | None | | x | | |
| | 5/23 | 1510 | lab | 250mL | G | 1 | x | | ww | H2SO4 | | | x | |
| | 5/23 | 1510 | site/eff1 | 250mL | G | 1 | x | | ww | H2SO4 | | | x | Preservative |
| | | | | | | | | | | | | | | pH Check: |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| | 5/23 | 1550 | UPS | | | | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | | | |

**Method of Delivery**
☐ UPS ☐ Fed Ex ☐ Hand Delivery
☐ UPS Overnight ☐ Post Office

**Remarks:**
Received @ _____ C
☐ Under 2 hours

**TAT**
Normal ____ Rush ____
Need Results by _____
Extra charges will apply for Rush TAT.

W.O.# _____
W.O.# _____

Amt Paid $_____
Check # _____

Revised 11/04/04

# SAMPLE CHAIN OF CUSTODY RECORD


**Company** Environmental System Services
**Contact** Cody Hoehna
**Address** 218 North Main Street
**Address** Culpeper, Va 22701
**Phone** 540-825-6660


## ENVIRONMENTAL SYSTEMS SERVICE, LTD.


218 North Main St.
Post Office Box 520
Culpeper, VA 22701
800-541-2116
540-825-6660

500 Stone St.
Post Office Box 736
Bedford, VA 24523
540-586-5413
Fax 540-586-5530


**Project Name/Site** The Madeira School WER Study **P.O.#**

**Sampled By:** Georgi Briggs (Print Name) (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | COLLECTION TIME | SAMPLE LOCATION | CONTAINERS SIZE | CONTAINERS G/P | CONTAINERS # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES TR Cu | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5/23 | 1520 | Lab control | 250mL | P | 1 | x | | ww | HNO3 | x | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| | 5/23 | 1520 | 5.88 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 8.40 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 12.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 17.2 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 24.5 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 35.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 50.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | Preservative |
| | 5/23 | 1530 | 5.4 / eff control | 250mL | P | 1 | x | | ww | HNO3 | x | pH Check: |
| | 5/23 | 1530 | 58.8 ppb site / eff | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1530 | 84.0 ppb site / eff | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1530 | 120 ppb site / eff | 250mL | P | 1 | x | | ww | HNO3 | x | |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| D. Bin | 5/23 | 1550 | UPS | | | | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | | | |

Method of Delivery
☐ UPS ☐ Fed Ex ☐ Hand Delivery
☐ UPS Overnight ☐ Post Office

Remarks:
Received @ _____ C
☐ Under 2 hours

TAT
Normal _____ Rush _____
Need Results by _____
Extra charges will apply for Rush TAT.

W.O.# _____
W.O.# _____

Amt Paid $_____
Check # _____

Revised 11/04/04

Monday 5.31.13

0852 At on Site: D.O. meter On

- Read Totalizer (Start 0.00) 4249588 x10
  4247006 x10
  25,820 Gal

- Pump Station
  Inf Pump 1 820.2 (2.0)
  Inf Pump 2 770.5 (1.5)
  P/S Level 99% 5.0m
  P/S Ops: Ok

0855 Cal. Hach PH meter
1st 4.00 at 20.5° Clr 7.0 at 21.5°
2nd 7.01 at 20.5° Slope 56.4 mV
3rd 10.05 at 21.5°

0903 Cal. Hach DO meter 8.77 at 21.5°

0914 D.O.: 8.91 at 20.5°

0914 PH Sample Collected

0918 PH: 7.89 at 20.5/20.7°

- PH Readings
  Inf 7.96 at 20.0°
  Train 1 Train 2
  1/31 7.08 at 20.7° 7.11 at 20.7°
- Soda Ash Vol. Rec. 1.11.2016s
- PH Set Hours 4,710. Changed
- DO Readings
  Train 1 Train 2
  4.28 at 20.6° 3.46 at 20.6°
- UV Hours
  Bank 1 OFFLINE
  Bank 2 9542 (5.9)
- Counter 95h 30m
- Pump Hours Record

Monday 5.21.12

- Bar Screen Rake
- EQ Traction Box. ok
- Returns. ok
- Clar. Lids. ok
- F. Lids. ok
- Note. D. Hall S. on Site performing Weir Study
- Completed Prof Paperwork
- Final Checks

1015 Left Site

0915 DS on site for WER Study

DC collected first sample 0900 (DS)

Collected 5 samples (4HC) 0800-1300 (DS)

1200 Collected Hardness, ~~E. Coli~~, Diss Cu + Tr Cu (DS)

1205 Collected E. Coli sample (DS)

1645 Collected Cl+ BOD, TSS + $NH_3$ (DS)

1715 Collected Ent HEM (DS)

Composited Samples for Bioassy + weekly sample

| | Flow | Factor | Volume | Operator |
|---|---|---|---|---|
| 0900 | 20.4 | 185 | 3780 | DS |
| 1000 | 23.1 | 185 | 4274 | DS |
| 1100 | 23.9 | 185 | 4421 | DS |
| 1200 | 23.7 | 185 | 4385 | DS |
| 1300 | 24.8 | 185 | 4588 | DS |

All day

DS + DC -66 Site

FILLED SODA ASH VAT 2V

218 North Main St. ♦ P.O. Box 520 ♦ Culpeper, Virginia 22701 ♦ Tel: (540) 825-6660 ♦ Fax (540) 825-4961 ♦ <www.ess-services.com>

# Analytical Report

Madeira School
ATTN: Ed Hamer
8328 Georgetown Pike
Mc Lean, VA 22102

| | |
|---|---|
| Report Date: | 06/08/2012 |
| Job #: | 0000120 |
| Customer #: | 0005780 |
| Customer PO #: | |
| Collected By: | ESS Employee |
| Sample Location: | Madeira School WER Study |

The test results submitted in this report relate only to the samples submitted and as received by Environmental Systems Service, Ltd.

All methods are Standard Methods, 19th edition unless otherwise noted.

Environmental Systems Service assumes no responsibility, express or implied, as to the interpretation of the analytical results contained in this report.

The signature on the final report certifies that these results conform to all applicable NELAC standards unless otherwise noted.

This laboratory report may not be reproduced, except in full, without the written approval of Environmental Systems Service, Ltd.

If you have received this report in error, please notify ESS immediately at (540) 825-6660.

Approved by: Angie Woodward

A. Woodward/Technical Director

Environmental Systems Service, Ltd.

# Analytical Report

Madeira School
ATTN: Ed Hamer
8328 Georgetown Pike
Mc Lean, VA 22102

Report Date: 06/08/2012
Job #: 0000120
Customer #: 0005780
Customer PO #:
Collected By: ESS Employee
Sample Location: Madeira School WER Study

**Sample ID#:** 0001214 **Sample Source:** Outfall 001
**Sample Date/Time:** 05/21/2012 / 13:00 **Date Received:** 05/21/2012

| Parameter | Results | Unit | Report Limit | Method | Analysis Date | Time | INIT |
|---|---|---|---|---|---|---|---|
| Biochemical Oxygen Demand | <2 | mg/l | 2 | SM 19 5210 | 05/22/2012 | 11:00 | KK |
| BOD blank and GGA outside of acceptance range. | | | | | | | |
| Total Suspended Solids | 1.50 | mg/l | 1.00 | SM 19 2540D | 05/24/2012 | 15:20 | JI |
| Ammonia, as N | <0.10 | mg/l | 0.10 | SM 19 4500NH3D | 05/25/2012 | 12:00 | BW |
| Conductivity | 870 | umhos/c | 1 | SM 19 2510B | 05/30/2012 | 11:35 | JW |
| Alkalinity as CaCO3 | 173 | mg/l | 5.00 | SM 19 2320B | 05/22/2012 | 12:00 | JI |
| Dissolved Organic Carbon | 6.64 | mg/l | 1 | SM 18 5310C | 05/31/2012 | 08:00 | 574 |
| Total Organic Carbon | 7.55 | mg/l | 1.00 | SM 18 5310C | 05/29/2012 | 08:00 | 574 |

**Sample ID#:** 0001215 **Sample Source:** Outfall 001
**Sample Date/Time:** 05/21/2012 / 12:00 **Date Received:** 05/21/2012

| Parameter | Results | Unit | Report Limit | Method | Analysis Date | Time | INIT |
|---|---|---|---|---|---|---|---|
| Copper, Total Recoverable | 0.0126 | mg/l | 0.0050 | EPA 200.8 | 05/24/2012 | 13:38 | 574 |
| Copper, Dissolved | 0.0130 | mg/l | 0.0050 | EPA 200.8 | 05/24/2012 | 13:38 | 574 |
| Escherichia coli (100 ml) | 1.0 | MPN | 1 | COLILERT-18 | 05/21/2012 | 16:10 | JI |
| Total Hardness as CaCO3 | 146 | mg/l | 2.00 | SM 19 2340C | 05/24/2012 | 15:40 | JW |

**Sample ID#:** 0001216 **Sample Source:** Influent
**Sample Date/Time:** 05/21/2012 / 12:15 **Date Received:** 05/21/2012

| Parameter | Results | Unit | Report Limit | Method | Analysis Date | Time | INIT |
|---|---|---|---|---|---|---|---|
| Biochemical Oxygen Demand | 212 | mg/l | 2 | SM 19 5210 | 05/22/2012 | 11:00 | KK |
| BOD blank and GGA outside of acceptance range. | | | | | | | |
| Total Suspended Solids | 92.1 | mg/l | 1.00 | SM 19 2540D | 05/24/2012 | 15:20 | JI |
| Ammonia, as N | 21.4 | mg/l | 0.10 | SM 19 4500NH3D | 05/25/2012 | 12:00 | BW |
| Hexane Extractable Material | 10.2 | mg/l | 5.00 | EPA 1664A | 05/31/2012 | 12:39 | 574 |

Environmental Systems Service, Ltd.

# Analytical Report

Madeira School
ATTN: Ed Hamer
8328 Georgetown Pike
Mc Lean, VA 22102

| | |
|---|---|
| Report Date: | 06/08/2012 |
| Job #: | 0000120 |
| Customer #: | 0005780 |
| Customer PO #: | |
| Collected By: | ESS Employee |
| Sample Location: | Madeira WER Study |

574 Samples subcontracted to VELAP ID# 460160

# SAMPLE CHAIN OF CUSTODY RECORD


Company _ Environmental System Services
Contact __ Cody Hoehna
Address _ 218 North Main Street
Address _ Culpeper, Va 22701
Phone ___ 540-825-6660


## ENVIRONMENTAL SYSTEMS SERVICE, LTD.


218 North Main St.
Post Office Box 520
Culpeper, VA 22701
800-541-2116
540-825-6660

500 Stone St.
Post Office Box 736
Bedford, VA 24523
540-586-5413
Fax 540-586-5530


Project Name/Site __ The Madeira School WER Study  P.O.#_____

Sampled By: Dillon Shields (Print Name)  (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | COLLECTION TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES: BOD, TSS (2) | NH3 (3) | DOC (5) | TOC (6) | TR Cu (1) | DISS Cu (2) | E. Coli (3) | Cond, ALK (4) | Hardness (4) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1214 | 5/21/12 | 0900 | Outfall 001 | 1L | P | 2 | | x | ww | None | x | | | | | | | | | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| 1214 | | 800 | Outfall 001 | 250mL | P | 1 | | x | ww | H2SO4 | | x | | | | | | | | |
| 1215 | | 1200 | Outfall 001 | 250mL | P | 2 | x | | ww | HNO3 | | | | | x | x | | | | |
| 1214 | | 0900 | Outfall 001 | 500mL | P | 1 | | x | ww | None | | | | | | | | x | | |
| 1214 | | 1300 | Outfall 001 | 250mL | G | 2 | | x | ww | H2SO4 | | | x | x | | | | | | |
| 1215 | | 1205 | Outfall 001 | 125mL | p | 1 | x | | ww | Na. Thios | | | | | | | x | | | |
| 1215 | | 1200 | Outfall 001 | 250mL | p | 1 | x | | ww | HNO3 | | | | | | | | | x | |
| 1216 | | 1145 | Influent | 1L | p | 2 | x | | ww | none | x | | | | | | | | | Preservative |
| 1216 | | 1145 | Influent | 250mL | P | 1 | x | | ww | H2SO4 | | A | | | | | | | | pH Check: |
| 1216 | 5/21/12 | 1215 | Influent | 1L | G | 1 | x | | ww | H2SO4 | H | E | M | (X) | | | | | | <2 |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| [signature] | 5/21/12 | 1310 | [signature] | [signature] | 5/21 | 1512 | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | 5/21/12 | 1312 | [signature] |

Method of Delivery
- ☐ UPS
- ☐ Fed Ex
- ☒ Hand Delivery
- ☐ UPS Overnight
- ☐ Post Office

Remarks: Received @ 2.2 C
- ☐ Under 2 hours

TAT
Normal ____ Rush ____
Need Results by _____
Extra charges will apply for Rush TAT.

W.O.# Job 120
W.O.# _____

Amt Paid $_____
Check # _____

Sample and
On

Revised 11/04/04

Madeira School WER Study MAY 2012
Spring 2012

| Sample ID | Analyzist | Result |
|---|---|---|
| Lab Control | Copper | <0.00500 |
| 5.88 PPB Lab | Copper | 0.00617 |
| 8.40 PPB Lab | Copper | 0.00762 |
| 12.0 PPB Lab | Copper | 0.0104 |
| 17.2 PPB Lab | Copper | 0.0139 |
| 24.5 PPB Lab | Copper | 0.0192 |
| 35.0 PPB Lab | Copper | 0.0273 |
| 50.0 PPB Lab | Copper | 0.0388 |
| Site/Eff Control | Copper | 0.0137 |
| 58.8 PPB Site/Eff | Copper | 0.0604 |
| 84.0 PPB Site/Eff | Copper | 0.0837 |
| 120 PPB Site/Eff | Copper | 0.112 |
| 172 PPB Site/Eff | Copper | 0.147 |
| 245 PPB Site/Eff | Copper | 0.206 |
| 350 PPB Site/Eff | Copper | 0.270 |
| 500 PPB Site/Fff | Copper | 0.406 |
| LAB | TSS | <1.00 |
| Site/Eff | TSS | <1.00 |
| LAB | DOC | <1 |
| Stie/Eff | DOC | 6.28 |

ANALYTICS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636001 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | LAB CONTROL | Date Collected: | 05/23/2012 15:20 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | <0.00500 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 17:54 HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | |
|---|---|---|---|
| Lab ID: | 1011636002 | Date Received: | 05/24/2012 11:00 Matrix Aqueous Liquid |
| Sample ID: | 5.88 PPB LAB | Date Collected: | 05/23/2012 15:20 Sample Type: GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.00617 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 18:09 HB | | V |

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636003 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 8.40 PPB LAB | Date Collected: | 05/23/2012 15:20 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.00762 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 18:14 HB | | V |



CERTIFICATE OF ANALYSIS

Analytics Corporation
10329 Stony Run Lane
Ashland, VA 23005
Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636004 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 12.0 PPB LAB | Date Collected: | 05/23/2012 15:20 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0104 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 18:19 HB | | V |

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Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636005 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 17.2 PPB LAB | Date Collected: | 05/23/2012 15:20 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0139 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 18:23 HB | | V |



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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636006 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 24.5 PPB LAB | Date Collected: | 05/23/2012 15:20 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0192 | mg/L | 0.0050 | 1 | 05/29/2012 15:34 | JRM | 5/30/2012 18:28 | HB | | V |

ANALYTICS

Analytics Corporation
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Ashland, VA 23005
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Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636007 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 35.0 PPB LAB | Date Collected: | 05/23/2012 15:20 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0273 | mg/L | 0.0050 | 1 | 05/29/2012 15:34 | JRM | 5/30/2012 18:33 | HB | | V |

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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636008 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 50.0 PPB LAB | Date Collected: | 05/23/2012 15:20 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0388 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 18:53 HB | | V |

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Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636009 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | SITE/EFFL CONTROL | Date Collected: | 05/23/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0137 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 18:58 HB | | V |



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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636010 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 58.8 PPB SITE/EFFL | Date Collected: | 05/23/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0604 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 19:03 HB | | V |

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Ashland, VA 23005
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Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

Lab ID: **1011636011** Date Received: 05/24/2012 11:00 Matrix Aqueous Liquid
Sample ID: **84.0 PPB SITE/EFFL** Date Collected: 05/23/2012 15:30 Sample Type: GRAB

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.0837 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 19:07 HB | | V |

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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636012 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 120 PPB SITE/EFFL | Date Collected: | 05/23/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.112 | mg/L | 0.0050 | 1 | 05/29/2012 15:34 | JRM | 5/30/2012 19:17 | HB | | V |



CERTIFICATE OF ANALYSIS

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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | **1011636013** | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | **172 PPB SITE/EFFL** | Date Collected: | 05/23/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.147 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 19:22 HB | | V |



CERTIFICATE OF ANALYSIS

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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636014 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 245 PPB SITE/EFFL | Date Collected: | 05/23/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.206 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 19:27 HB | | V |

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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636015 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | 350 PPB SITE/EFFL | Date Collected: | 05/23/2012 15:30 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper | 0.270 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 19:32 HB | | V |

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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | |
|---|---|---|---|
| Lab ID: | **1011636016** | Date Received: | 05/24/2012 11:00 Matrix Aqueous Liquid |
| Sample ID: | **500 PPB SITE/EFFL** | Date Collected: | 05/23/2012 15:30 Sample Type: GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: EPA 200.8 | | | | | Preparation Method: EPA 200.8 | | | | | |
| Copper , | 0.406 | mg/L | 0.0050 | 1 | 05/29/2012 | 15:34 JRM | 5/30/2012 | 19:37 HB | | V |

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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636017 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | LAB | Date Collected: | 05/23/2012 15:10 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: SM 2540 D | | | | | Preparation Method: SM 2540 D | | | | | |
| Total Suspended Solids | <1.00 | mg/L | 1.00 | 1 | 05/30/2012 | 14:45 JLC | 5/31/2012 | 14:45 JWB | | V |



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Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636018 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | SITE/EFFL | Date Collected: | 05/23/2012 15:10 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: SM 2540 D | | | | | Preparation Method: SM 2540 D | | | | | |
| Total Suspended Solids | <1.00 | mg/L | 1.00 | 1 | 05/30/2012 | 14:45 JLC | 5/31/2012 | 14:45 JWB | | V |



CERTIFICATE OF ANALYSIS

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Phone: (804) 365-3000
Fax: (908) 365-3002

## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | |
|---|---|---|---|
| Lab ID: | 1011636019 | Date Received: | 05/24/2012 11:00 Matrix Aqueous Liquid |
| Sample ID: | LAB | Date Collected: | 05/23/2012 15:10 Sample Type: GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method:. SM 5310 C | | | | | | | | | | |
| DOC | <1 | mg/L | 1 | 1 | NA | NA | 5/31/2012 | 08:00 JWB | | |



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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

| | | | | | |
|---|---|---|---|---|---|
| Lab ID: | 1011636020 | Date Received: | 05/24/2012 11:00 | Matrix | Aqueous Liquid |
| Sample ID: | SITE/EFFL | Date Collected: | 05/23/2012 15:10 | Sample Type: | GRAB |

| Parameters | Results | Units | Report Limi | DF | Prepared | By | Analyzed | By | Qual | Certifications |
|---|---|---|---|---|---|---|---|---|---|---|
| Analytical Method: SM 5310 C | | | | | | | | | | |
| DOC | 6.28 | mg/L | 1 | 1 | NA | NA | 6/4/2012 | 13:00 JWB | | |



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Phone: (804) 365-3000
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## ANALYTICAL RESULTS

Workorder: 1011636 THE MADEIRA SCHOOL WER STUDY

**Qualifiers**

-

Certification Index:

V = Virginia (NELAC) - 1 VAC 30-46 H 1, Laboratory ID: 460160, Certificate #: 1449

# SAMPLE CHAIN OF CUSTODY RECORD


**Company** Environmental System Services
**Contact** Cody Hoehna
**Address** 218 North Main Street
**Address** Culpeper, Va 22701
**Phone** 540-825-6660


## ENVIRONMENTAL SYSTEMS SERVICE, LTD.


218 North Main St.
Post Office Box 520
Culpeper, VA 22701
800-541-2116
540-825-6660

500 Stone St.
Post Office Box 736
Bedford, VA 24523
540-586-5413
Fax 540-586-5530


**Project Name/Site** The Madeira School WER Study **P.O.#**

**Sampled By:** Georgi Briggs (Print Name) (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES: TR Cu | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5/23 | 1520 | Lab control | 250mL | P | 1 | x | | ww | HNO3 | x | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| | 5/23 | 1520 | 5.88 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 8.40 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 12.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 17.2 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 24.5 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 35.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1520 | 50.0 ppb lab | 250mL | P | 1 | x | | ww | HNO3 | x | Preservative |
| | 5/23 | 1530 | Site/effl control | 250mL | P | 1 | x | | ww | HNO3 | x | pH Check: |
| | 5/23 | 1530 | 58.8 ppb site/effl | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1530 | 84.0 ppb site/effl | 250mL | P | 1 | x | | ww | HNO3 | x | |
| | 5/23 | 1530 | 120 ppb site/effl | 250mL | P | 1 | x | | ww | HNO3 | x | |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| D. Briggs | 5/23 | 1550 | UPS | | | | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | 5-24-12 | 1100 | JAMES ALTIER |

**Method of Delivery**
☐ UPS ☐ Fed Ex ☐ Hand Delivery
☐ UPS Overnight ☐ Post Office

**Remarks:**
Received @ 14.0 C
☐ Under 2 hours

**TAT**
Normal ____ Rush ____
Need Results by ____
Extra charges will apply for Rush TAT.

W.O.# ____
W.O.# ____

Amt Paid $____
Check # ____

Revised 11/04/04

# SAMPLE CHAIN OF CUSTODY RECORD


Company Environmental System Services
Contact Cody Hoehna
Address 218 North Main Street
Address Culpeper, Va 22701
Phone 540-825-6660


## ENVIRONMENTAL SYSTEMS SERVICE, LTD.


218 North Main St.
Post Office Box 520
Culpeper, VA 22701
800-541-2116
540-825-6660

500 Stone St.
Post Office Box 736
Bedford, VA 24523
540-586-5413
Fax 540-586-5530


**Project Name/Site** The Madeira School WER Study **P.O.#**

**Sampled By:** Geoff Briggs (Print Name) (Signature)

| ESS SAMPLE ID. | COLLECTION DATE | TIME | SAMPLE LOCATION | CONTAINERS SIZE | G/P | # | GRAB | COMP | SAMPLE MATRIX | PRESERVATIVE | ANALYSES: TR Cu | TSS | DOC | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5/23 | 1530 | 172ppb site/effl | 250mL | P | 1 | x | | ww | HNO3 | x | | | *Metals: Analyze using method 200.8 and a detection level of 5 ug/L |
| | 5/23 | 1530 | 245ppb site/effl | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| | 5/23 | 1530 | 350 ppb site/effl | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| | 5/23 | 1530 | 500 ppb site/effl | 250mL | P | 1 | x | | ww | HNO3 | x | | | |
| | 5/23 | 1510 | lab | 1L | P | 1 | x | | ww | None | | x | | |
| | 5/23 | 1510 | site/effl | 1L | P | 1 | x | | ww | None | | x | | |
| | 5/23 | 1510 | lab | 250mL | G | 1 | x | | ww | H2SO4 | | | x | |
| | 5/23 | 1510 | site/effl | 250mL | G | 1 | x | | ww | H2SO4 | | | x | Preservative |
| | | | | | | | | | | | | | | pH Check: |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received by: |
|---|---|---|---|---|---|---|---|
| DBA | 5/23 | 1550 | UPS | | | | |
| Relinquished by: | Date | Time | Received by: | Relinquished by: | Date | Time | Received for Laboratory by: |
| | | | | | 5-24-12 | 1100 | JAMES ALTIER OK |

Method of Delivery
- ☐ UPS ☐ Fed Ex ☐ Hand Delivery
- ☐ UPS Overnight ☐ Post Office

Remarks:
Received @ 14.0 C
☐ Under 2 hours

TAT
Normal ____ Rush ____
Need Results by ____
Extra charges will apply for Rush TAT.

W.O.# ____
W.O.# ____

Amt Paid $____
Check # ____

Revised 11/04/04

10/16/2013 2:24:18 PM

Facility = Madeira School
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 8.73
WLAc = 1.31
Q.L. = .2
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
# < Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 2.64314782237537
Average Weekly limit = 2.64314782237537
Average Monthly LImit = 1.80718815283442

The data are:

9

10/28/2013 3:05:45 PM

Facility = Madeira School
Chemical = Copper
Chronic averaging period = 4
WLAa = 114
WLAc = 72
Q.L. = .2
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 43
Expected Value = 18.3928
Variance = 36.2923
C.V. = 0.327534
97th percentile daily values = 31.8640
97th percentile 4 day average = 24.6491
97th percentile 30 day average= 20.4617
# < Q.L. = 0
Model used = lognormal

No Limit is required for this material

The data are:

16
18
21
24
18
16
15
13
15
13
15
12
14
14
15
19
17
19
23
24
21
19
12

14
16
17
18
9
26
25
24.5
17.8
20
5
27.6
16.3
20
20
21
27
24
27
17

REGIONAL MODELING SYSTEM VERSION 3.2

MODEL SIMULATION FOR THE Madeira School STP DISCHARGE

TO Unnamed Tributary to Difficult Run

COMMENT: Madeira School STP Stream Model

---

THE SIMULATION STARTS AT THE Madeira School STP DISCHARGE

PROPOSED PERMIT LIMITS

FLOW = .04 MGD cBOD5 = 30 Mg/L TKN = 20 Mg/L D.O. = 6 Mg/L

**** THE MAXIMUM CHLORINE ALLOWABLE IN THE DISCHARGE IS 0.011 Mg/L ****

---

THE SECTION BEING MODELED IS BROKEN INTO 3 SEGMENTS
RESULTS WILL BE GIVEN AT 0.1 MILE INTERVALS

BACKGROUND CONDITIONS

THE 7Q10 STREAM FLOW AT THE DISCHARGE IS 0.00000 MGD
THE DISSOLVED OXYGEN OF THE STREAM IS 7.480 Mg/L
THE BACKGROUND cBOD$_u$ OF THE STREAM IS 5 Mg/L
THE BACKGROUND nBOD OF THE STREAM IS 0 Mg/L

MODEL PARAMETERS

| SEG. | LEN. Mi | VEL. F/S | K2 1/D | K1 1/D | KN 1/D | BENTHIC Mg/L | ELEV. Ft | TEMP. °C | DO-SAT Mg/L |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.07 | 0.823 | 20.000 | 1.800 | 0.700 | 1.219 | 82.50 | 25.00 | 8.311 |
| 2 | 0.15 | 0.523 | 20.000 | 1.500 | 0.600 | 0.000 | 62.50 | 25.00 | 8.317 |
| 3 | 5.00 | 0.823 | 2.400 | 1.500 | 0.500 | 0.000 | 50.00 | 25.00 | 8.321 |

(The K Rates shown are at 20°C ... the model corrects them for temperature.)

4/8/92 - 0.04 MGD MODEL

**Attachment 11**

********** RESPONSE FOR SEGMENT 1 **********

TOTAL STREAMFLOW = 0.0400 MGD
(Including Discharge)

| DISTANCE FROM HEAD OF SEGMENT (MI.) | TOTAL DISTANCE FROM MODEL BEGINNING (MI.) | DISSOLVED OXYGEN (Mg/L) | cBODu (Mg/L) | nBODu (Mg/L) |
|---|---|---|---|---|
| 0.000 | 0.000 | 6.000 | 75.000 | 73.610 |
| 0.070 | 0.070 | 5.048 | 74.122 | 73.217 |

FOR THE TRIBUTARY AT THE END OF SEGMENT 1
FLOW = 1.81 MGD cBOD5 = 2 Mg/L TKN = 0 Mg/L D.O. = 7.48 Mg/L

FLOW FROM INCREMENTAL DRAINAGE AREA = 0.0031 MGD

********** RESPONSE FOR SEGMENT 2 **********

TOTAL STREAMFLOW = 1.8531 MGD
(Including Discharge, Tributaries and Incremental D.A. Flow)

| DISTANCE FROM HEAD OF SEGMENT (MI.) | TOTAL DISTANCE FROM MODEL BEGINNING (MI.) | DISSOLVED OXYGEN (Mg/L) | cBODu (Mg/L) | nBODu (Mg/L) |
|---|---|---|---|---|
| 0.000 | 0.070 | 7.427 | 6.492 | 1.580 |
| 0.100 | 0.170 | 7.485 | 6.350 | 1.564 |
| 0.150 | 0.220 | 7.485 | 6.281 | 1.556 |

FOR THE TRIBUTARY AT THE END OF SEGMENT 2
FLOW = 631 MGD cBOD5 = 2 Mg/L TKN = 0 Mg/L D.O. = 7.4853 Mg/L

FLOW FROM INCREMENTAL DRAINAGE AREA = 0.0062 MGD

TOTAL STREAMFLOW = 632.8594 MGD
(Including Discharge, Tributaries and Incremental D.A. Flow)

| DISTANCE FROM HEAD OF SEGMENT (MI.) | TOTAL DISTANCE FROM MODEL BEGINNING (MI.) | DISSOLVED OXYGEN (Mg/L) | cBODu (Mg/L) | nBODu (Mg/L) |
|---|---|---|---|---|
| 0.000 | 0.220 | 7.485 | 5.004 | 0.005 |
| 0.100 | 0.320 | 7.433 | 5.000 | 0.005 |
| 0.200 | 0.420 | 7.451 | 5.000 | 0.005 |
| 0.300 | 0.520 | 7.468 | 5.000 | 0.005 |
| 0.400 | 0.620 | 7.485 | 5.000 | 0.005 |
| 0.500 | 0.720 | 7.489 | 5.000 | 0.005 |
| 0.600 | 0.820 | 7.489 | 5.000 | 0.005 |
| 0.700 | 0.920 | 7.489 | 5.000 | 0.005 |
| 0.800 | 1.020 | 7.489 | 5.000 | 0.005 |
| 0.900 | 1.120 | 7.489 | 5.000 | 0.005 |
| 1.000 | 1.220 | 7.489 | 5.000 | 0.005 |
| 1.100 | 1.320 | 7.489 | 5.000 | 0.005 |
| 1.200 | 1.420 | 7.489 | 5.000 | 0.005 |
| 1.300 | 1.520 | 7.489 | 5.000 | 0.005 |
| 1.400 | 1.620 | 7.489 | 5.000 | 0.005 |
| 1.500 | 1.720 | 7.489 | 5.000 | 0.005 |
| 1.600 | 1.820 | 7.489 | 5.000 | 0.005 |
| 1.700 | 1.920 | 7.489 | 5.000 | 0.005 |
| 1.800 | 2.020 | 7.489 | 5.000 | 0.005 |
| 1.900 | 2.120 | 7.489 | 5.000 | 0.005 |
| 2.000 | 2.220 | 7.489 | 5.000 | 0.005 |
| 2.100 | 2.320 | 7.489 | 5.000 | 0.005 |
| 2.200 | 2.420 | 7.489 | 5.000 | 0.005 |
| 2.300 | 2.520 | 7.489 | 5.000 | 0.005 |
| 2.400 | 2.620 | 7.489 | 5.000 | 0.005 |
| 2.500 | 2.720 | 7.489 | 5.000 | 0.005 |
| 2.600 | 2.820 | 7.489 | 5.000 | 0.005 |
| 2.700 | 2.920 | 7.489 | 5.000 | 0.005 |
| 2.800 | 3.020 | 7.489 | 5.000 | 0.005 |
| 2.900 | 3.120 | 7.489 | 5.000 | 0.005 |
| 3.000 | 3.220 | 7.489 | 5.000 | 0.005 |
| 3.100 | 3.320 | 7.489 | 5.000 | 0.005 |
| 3.200 | 3.420 | 7.489 | 5.000 | 0.005 |
| 3.300 | 3.520 | 7.489 | 5.000 | 0.005 |
| 3.400 | 3.620 | 7.489 | 5.000 | 0.005 |
| 3.500 | 3.720 | 7.489 | 5.000 | 0.005 |
| 3.600 | 3.820 | 7.489 | 5.000 | 0.005 |
| 3.700 | 3.920 | 7.489 | 5.000 | 0.005 |
| 3.800 | 4.020 | 7.489 | 5.000 | 0.005 |
| 3.900 | 4.120 | 7.489 | 5.000 | 0.005 |
| 4.000 | 4.220 | 7.489 | 5.000 | 0.005 |
| 4.100 | 4.320 | 7.489 | 5.000 | 0.005 |
| 4.200 | 4.420 | 7.489 | 5.000 | 0.005 |
| 4.300 | 4.520 | 7.489 | 5.000 | 0.005 |
| 4.400 | 4.620 | 7.489 | 5.000 | 0.005 |
| 4.500 | 4.720 | 7.489 | 5.000 | 0.005 |
| 4.600 | 4.820 | 7.489 | 5.000 | 0.005 |
| 4.700 | 4.920 | 7.489 | 5.000 | 0.005 |

| | | | | |
|---|---|---|---|---|
| 4.800 | 5.0 | 7.489 | 000 | 0.005 |
| 4.900 | 5.120 | 7.489 | 5.000 | 0.005 |
| 5.000 | 5.220 | 7.489 | 5.000 | 0.005 |

**********

REGIONAL MODELING SYSTEM Ver 3.2 (OWRM - 9/90)
04-08-1992 20:30:54

DATA FILE = MADEIRA1.MOD

REGIONAL MODELING SYSTEM VERSION 3.2

# DATA FILE SUMMARY

THE NAME OF THE DATA FILE IS: MADEIRA1.MOD

THE STREAM NAME IS: Unnamed Tributary to Difficult Run
THE RIVER BASIN IS: Potomac
THE SECTION NUMBER IS: 8
THE CLASSIFICATION IS: 3

STANDARDS VIOLATED (Y/N) = N
STANDARDS APPROPRIATE (Y/N) = Y

DISCHARGE WITHIN 3 MILES (Y/N) = N

THE DISCHARGE BEING MODELED IS: Madeira School STP

PROPOSED LIMITS ARE:
FLOW = .04 MGD
BOD5 = 30 MG/L
TKN = 20 MG/L
D.O. = 6 MG/L

THE NUMBER OF SEGMENTS TO BE MODELED = 3

7Q10 WILL BE CALCULATED BY: DRAINAGE AREA COMPARISON
THE GAUGE NAME IS: Difficult Run Near Great Falls
GAUGE DRAINAGE AREA = 58 SQ.MI.
GAUGE 7Q10 = 1.81 MGD
DRAINAGE AREA AT DISCHARGE = .5 SQ.MI.

STREAM A DRY DITCH AT DISCHARGE (Y/N) = Y
ANTIDEGRADATION APPLIES (Y/N) = Y

ALLOCATION DESIGN TEMPERATURE = 25 °C

SEGMENT INFORMATION

####### SEGMENT # 1 #######

SEGMENT ENDS BECAUSE: A TRIBUTARY ENTERS AT END

SEGMENT LENGTH = .07 MI

SEGMENT WIDTH = 1 FT
SEGMENT DEPTH = .25 FT
SEGMENT VELOCITY = .25 FT/SEC

DRAINAGE AREA AT SEGMENT START = .5 SQ.MI.
DRAINAGE AREA AT SEGMENT END = .6 SQ.MI.

ELEVATION AT UPSTREAM END = 100 FT
ELEVATION AT DOWNSTREAM END = 65 FT

THE CROSS SECTION IS: IRREGULAR
THE CHANNEL IS: MODERATELY MEANDERING

POOLS AND RIFFLES (Y/N) = Y
THE SEGMENT LENGTH IS 40 % POOLS
POOL DEPTH = .6 FT
THE SEGMENT LENGTH IS 60 % RIFFLES
RIFFLE DEPTH = .08 FT

THE BOTTOM TYPE = SMALL ROCK
SLUDGE DEPOSITS = LIGHT
AQUATIC PLANTS = NONE
ALGAE OBSERVED = NONE
WATER COLORED GREEN (Y/N) = N

TRIBUTARY DATA
FLOW = 1.81 MGD
BOD5 = 2 MG/L
TKN = 0 MG/L
D.O. = 7.48 MG/L

SEGMENT INFORMAT

####### SEGMENT # 2 #######

SEGMENT ENDS BECAUSE: A TRIBUTARY ENTERS AT END

SEGMENT LENGTH = .15 MI

SEGMENT WIDTH = 12 FT
SEGMENT DEPTH = .6 FT
SEGMENT VELOCITY = .4 FT/SEC

DRAINAGE AREA AT SEGMENT START = 58.4 SQ.MI.
DRAINAGE AREA AT SEGMENT END = 58.6 SQ.MI.

ELEVATION AT UPSTREAM END = 65 FT
ELEVATION AT DOWNSTREAM END = 60 FT

THE CROSS SECTION IS: WIDE SHALLOW ARC
THE CHANNEL IS: MODERATELY MEANDERING

POOLS AND RIFFLES (Y/N) = N

THE BOTTOM TYPE = SMALL ROCK
SLUDGE DEPOSITS = NONE
AQUATIC PLANTS = NONE
ALGAE OBSERVED = NONE
WATER COLORED GREEN (Y/N) = N

TRIBUTARY DATA
FLOW = 631 MGD
BOD5 = 2 MG/L
TKN = 0 MG/L
D.O. = 7.4853 MG/L

SEGMENT INFORMA N

######## SEGMENT # 3 ########

SEGMENT ENDS BECAUSE: THE MODEL ENDS

SEGMENT LENGTH = 5 MI

SEGMENT WIDTH = 480 FT
SEGMENT DEPTH = 4 FT
SEGMENT VELOCITY = .5 FT/SEC

DRAINAGE AREA AT SEGMENT START = 11300 SQ.MI.
DRAINAGE AREA AT SEGMENT END = 11500 SQ.MI.

ELEVATION AT UPSTREAM END = 60 FT
ELEVATION AT DOWNSTREAM END = 40 FT

THE CROSS SECTION IS: WIDE SHALLOW ARC
THE CHANNEL IS: MODERATELY MEANDERING

POOLS AND RIFFLES (Y/N) = N

THE BOTTOM TYPE = SILT
SLUDGE DEPOSITS = NONE
AQUATIC PLANTS = FEW
ALGAE OBSERVED = NONE
WATER COLORED GREEN (Y/N) = N

**********

REGIONAL MODELING SYSTEM VERSION 3.2

MODEL SIMULATION FOR THE The Maderia School DISCHARGE

TO Difficult Run, UT

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THE SIMULATION STARTS AT THE The Maderia School DISCHARGE

PROPOSED PERMIT LIMITS

FLOW = .0495 MGD cBOD5 = 30 Mg/L TKN = 3.75 Mg/L D.O. = 6 Mg/L

**** THE MAXIMUM CHLORINE ALLOWABLE IN THE DISCHARGE IS 0.011 Mg/L ****

---

THE SECTION BEING MODELED IS BROKEN INTO 3 SEGMENTS
RESULTS WILL BE GIVEN AT 0.1 MILE INTERVALS

BACKGROUND CONDITIONS

THE 7Q10 STREAM FLOW AT THE DISCHARGE IS 0.00000 MGD
THE DISSOLVED OXYGEN OF THE STREAM IS 7.475 Mg/L
THE BACKGROUND cBODu OF THE STREAM IS 5 Mg/L
THE BACKGROUND nBOD OF THE STREAM IS 0 Mg/L

MODEL PARAMETERS

| SEG. | LEN. Mi | VEL. F/S | K2 1/D | K1 1/D | KN 1/D | BENTHIC Mg/L | ELEV. Ft | TEMP. °C | DO-SAT Mg/L |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.10 | 0.971 | 20.000 | 1.800 | 0.350 | 0.000 | 100.00 | 25.00 | 8.306 |
| 2 | 0.30 | 0.369 | 20.000 | 1.300 | 0.150 | 0.000 | 65.00 | 25.00 | 8.316 |
| 3 | 5.00 | 0.525 | 1.200 | 1.500 | 0.250 | 0.000 | 55.00 | 25.00 | 8.319 |

(The K Rates shown are at 20°C ... the model corrects them for temperature.)

PROPOSED PERMIT LIMITS:

TKN OF 3.0 MG/L MINIMUM + 50% OF MONTHLY AVERAGE AMMONIA LIMITATION OF 1.5 MG/L. 50% = 0.75 MG/L

THEREFORE, PROPOSED TKN = 3.0 MG/L + 0.75 MG/L, OR

3.75 MG/L TKN

ATTACHMENT #13

********** RESPONSE FOR SEGMENT 1 **********

TOTAL STREAMFLOW = 0.0495 MGD
(Including Discharge)

| DISTANCE FROM HEAD OF SEGMENT (MI.) | TOTAL DISTANCE FROM MODEL BEGINNING (MI.) | DISSOLVED OXYGEN (Mg/L) | cBODu (Mg/L) | nBODu (Mg/L) |
|---|---|---|---|---|
| 0.000 | 0.000 | 6.000 | 75.000 | 3.247 |
| 0.100 | 0.100 | 5.306 | 73.939 | 3.237 |

FOR THE TRIBUTARY AT THE END OF SEGMENT 1
FLOW = 1.9 MGD cBOD5 = 2 Mg/L TKN = 0 Mg/L D.O. = 7.4754 Mg/L

FLOW FROM INCREMENTAL DRAINAGE AREA = 0.0081 MGD

TOTAL STREAMFLOW = 1.9576 MGD
(Including Discharge, Tributaries and Incremental D.A. Flow)

| DISTANCE FROM HEAD OF SEGMENT (MI.) | TOTAL DISTANCE FROM MODEL BEGINNING (MI.) | DISSOLVED OXYGEN (Mg/L) | cBODu (Mg/L) | nBODu (Mg/L) |
|---|---|---|---|---|
| 0.000 | 0.100 | 7.420 | 6.743 | 0.082 |
| 0.100 | 0.200 | 7.485 | 6.563 | 0.082 |
| 0.200 | 0.300 | 7.485 | 6.387 | 0.081 |
| 0.300 | 0.400 | 7.485 | 6.217 | 0.081 |

FOR THE TRIBUTARY AT THE END OF SEGMENT 2
FLOW = 410 MGD cBOD5 = 2 Mg/L TKN = 0 Mg/L D.O. = 7.4846 Mg/L

FLOW FROM INCREMENTAL DRAINAGE AREA = 0.0588 MGD

********** RESPONSE FOR SEGMENT 3 **********

TOTAL STREAMFLOW = 412.0164 MGD
(Including Discharge, Tributaries and Incremental D.A. Flow)

| DISTANCE FROM HEAD OF SEGMENT (MI.) | TOTAL DISTANCE FROM MODEL BEGINNING (MI.) | DISSOLVED OXYGEN (Mg/L) | cBODu (Mg/L) | nBODu (Mg/L) |
|---|---|---|---|---|
| 0.000 | 0.400 | 7.485 | 5.006 | 0.000 |
| 0.100 | 0.500 | 7.390 | 5.000 | 0.000 |
| 0.200 | 0.600 | 7.404 | 5.000 | 0.000 |
| 0.300 | 0.700 | 7.419 | 5.000 | 0.000 |
| 0.400 | 0.800 | 7.433 | 5.000 | 0.000 |
| 0.500 | 0.900 | 7.446 | 5.000 | 0.000 |
| 0.600 | 1.000 | 7.460 | 5.000 | 0.000 |
| 0.700 | 1.100 | 7.473 | 5.000 | 0.000 |
| 0.800 | 1.200 | 7.487 | 5.000 | 0.000 |
| 0.900 | 1.300 | 7.487 | 5.000 | 0.000 |
| 1.000 | 1.400 | 7.487 | 5.000 | 0.000 |
| 1.100 | 1.500 | 7.487 | 5.000 | 0.000 |
| 1.200 | 1.600 | 7.487 | 5.000 | 0.000 |
| 1.300 | 1.700 | 7.487 | 5.000 | 0.000 |
| 1.400 | 1.800 | 7.487 | 5.000 | 0.000 |
| 1.500 | 1.900 | 7.487 | 5.000 | 0.000 |
| 1.600 | 2.000 | 7.487 | 5.000 | 0.000 |
| 1.700 | 2.100 | 7.487 | 5.000 | 0.000 |
| 1.800 | 2.200 | 7.487 | 5.000 | 0.000 |
| 1.900 | 2.300 | 7.487 | 5.000 | 0.000 |
| 2.000 | 2.400 | 7.487 | 5.000 | 0.000 |
| 2.100 | 2.500 | 7.487 | 5.000 | 0.000 |
| 2.200 | 2.600 | 7.487 | 5.000 | 0.000 |
| 2.300 | 2.700 | 7.487 | 5.000 | 0.000 |
| 2.400 | 2.800 | 7.487 | 5.000 | 0.000 |
| 2.500 | 2.900 | 7.487 | 5.000 | 0.000 |
| 2.600 | 3.000 | 7.487 | 5.000 | 0.000 |
| 2.700 | 3.100 | 7.487 | 5.000 | 0.000 |
| 2.800 | 3.200 | 7.487 | 5.000 | 0.000 |
| 2.900 | 3.300 | 7.487 | 5.000 | 0.000 |
| 3.000 | 3.400 | 7.487 | 5.000 | 0.000 |
| 3.100 | 3.500 | 7.487 | 5.000 | 0.000 |
| 3.200 | 3.600 | 7.487 | 5.000 | 0.000 |
| 3.300 | 3.700 | 7.487 | 5.000 | 0.000 |
| 3.400 | 3.800 | 7.487 | 5.000 | 0.000 |
| 3.500 | 3.900 | 7.487 | 5.000 | 0.000 |
| 3.600 | 4.000 | 7.487 | 5.000 | 0.000 |
| 3.700 | 4.100 | 7.487 | 5.000 | 0.000 |
| 3.800 | 4.200 | 7.487 | 5.000 | 0.000 |
| 3.900 | 4.300 | 7.487 | 5.000 | 0.000 |
| 4.000 | 4.400 | 7.487 | 5.000 | 0.000 |
| 4.100 | 4.500 | 7.487 | 5.000 | 0.000 |
| 4.200 | 4.600 | 7.487 | 5.000 | 0.000 |
| 4.300 | 4.700 | 7.487 | 5.000 | 0.000 |
| 4.400 | 4.800 | 7.487 | 5.000 | 0.000 |
| 4.500 | 4.900 | 7.487 | 5.000 | 0.000 |
| 4.600 | 5.000 | 7.487 | 5.000 | 0.000 |
| 4.700 | 5.100 | 7.487 | 5.000 | 0.000 |

| | | | | |
|---|---|---|---|---|
| 4.800 | 5.200 | 7.487 | 5.000 | 0.000 |
| 4.900 | 5.300 | 7.487 | 5.000 | 0.000 |
| 5.000 | 5.400 | 7.487 | 5.000 | 0.000 |

**********

REGIONAL MODELING SYSTEM Ver 3.2 (OWRM - 9/90)
03-11-1998 14:32:49

DATA FILE = MAD3.MOD

REGIONAL MODELING SYSTEM VERSION 3.2

DATA FILE SUMMARY

THE NAME OF THE DATA FILE IS: MAD3.MOD

THE STREAM NAME IS: Difficult Run, UT
THE RIVER BASIN IS: Potomac
THE SECTION NUMBER IS: 8
THE CLASSIFICATION IS: III

STANDARDS VIOLATED (Y/N) = N
STANDARDS APPROPRIATE (Y/N) = Y

DISCHARGE WITHIN 3 MILES (Y/N) = N

THE DISCHARGE BEING MODELED IS: The Maderia School

PROPOSED LIMITS ARE:
FLOW = .0495 MGD
BOD5 = 30 MG/L
TKN = 3.75 MG/L
D.O. = 6 MG/L

THE NUMBER OF SEGMENTS TO BE MODELED = 3

7Q10 WILL BE CALCULATED BY: DRAINAGE AREA COMPARISON
THE GAUGE NAME IS: Difficult Run
GAUGE DRAINAGE AREA = 57.9 SQ.MI.
GAUGE 7Q10 = 1.87 MGD
DRAINAGE AREA AT DISCHARGE = .75 SQ.MI.

STREAM A DRY DITCH AT DISCHARGE (Y/N) = Y
ANTIDEGRADATION APPLIES (Y/N) = Y

ALLOCATION DESIGN TEMPERATURE = 25 °C

SEGMENT INFORMATION

####### SEGMENT # 1 #######

SEGMENT ENDS BECAUSE: A TRIBUTARY ENTERS AT END

SEGMENT LENGTH = .1 MI

SEGMENT WIDTH = ..5 FT
SEGMENT DEPTH = .2 FT
SEGMENT VELOCITY = .8 FT/SEC

DRAINAGE AREA AT SEGMENT START = .75 SQ.MI.
DRAINAGE AREA AT SEGMENT END = 1 SQ.MI.

ELEVATION AT UPSTREAM END = 130 FT
ELEVATION AT DOWNSTREAM END = 70 FT

THE CROSS SECTION IS: IRREGULAR
THE CHANNEL IS: MOSTLY STRAIGHT

POOLS AND RIFFLES (Y/N) = Y
THE SEGMENT LENGTH IS 0 % POOLS
POOL DEPTH = 0 FT
THE SEGMENT LENGTH IS 100 % RIFFLES
RIFFLE DEPTH = .2 FT

THE BOTTOM TYPE = LARGE ROCK
SLUDGE DEPOSITS = NONE
AQUATIC PLANTS = NONE
ALGAE OBSERVED = NONE
WATER COLORED GREEN (Y/N) = N

TRIBUTARY DATA
FLOW = 1.9 MGD
BOD5 = 2 MG/L
TKN = 0 MG/L
D.O. = 7.4754 MG/L

SEGMENT INFORMATION

####### SEGMENT # 2 #######

SEGMENT ENDS BECAUSE: A TRIBUTARY ENTERS AT END

SEGMENT LENGTH = .3 MI

SEGMENT WIDTH = 20 FT
SEGMENT DEPTH = .5 FT
SEGMENT VELOCITY = .3 FT/SEC

DRAINAGE AREA AT SEGMENT START = 58.18 SQ.MI.
DRAINAGE AREA AT SEGMENT END = 60 SQ.MI.

ELEVATION AT UPSTREAM END = 70 FT
ELEVATION AT DOWNSTREAM END = 60 FT

THE CROSS SECTION IS: WIDE SHALLOW ARC
THE CHANNEL IS: MODERATELY MEANDERING

POOLS AND RIFFLES (Y/N) = Y
THE SEGMENT LENGTH IS 50 % POOLS
POOL DEPTH = .75 FT
THE SEGMENT LENGTH IS 50 % RIFFLES
RIFFLE DEPTH = .25 FT

THE BOTTOM TYPE = LARGE ROCK
SLUDGE DEPOSITS = NONE
AQUATIC PLANTS = NONE
ALGAE OBSERVED = NONE
WATER COLORED GREEN (Y/N) = N

TRIBUTARY DATA
FLOW = 410 MGD
BOD5 = 2 MG/L
TKN = 0 MG/L
D.O. = 7.4846 MG/L

SEGMENT INFORMATION

####### SEGMENT # 3 #######

SEGMENT ENDS BECAUSE: THE MODEL ENDS

SEGMENT LENGTH = 5 MI

SEGMENT WIDTH = 300 FT
SEGMENT DEPTH = 4 FT
SEGMENT VELOCITY = .5 FT/SEC

DRAINAGE AREA AT SEGMENT START = 11494 SQ.MI.
DRAINAGE AREA AT SEGMENT END = 11560 SQ.MI.

ELEVATION AT UPSTREAM END = 60 FT
ELEVATION AT DOWNSTREAM END = 50 FT

THE CROSS SECTION IS: RECTANGULAR
THE CHANNEL IS: MODERATELY MEANDERING

POOLS AND RIFFLES (Y/N) = N

THE BOTTOM TYPE = SMALL ROCK
SLUDGE DEPOSITS = NONE
AQUATIC PLANTS = NONE
ALGAE OBSERVED = NONE
WATER COLORED GREEN (Y/N) = N

**********

REGIONAL MODELING SYSTEM Ver 3.2 (OWRM - 9/90)
03-11-1998 14:32:52

# STREAM INSPECTION REPORT FORM

Discharge Name: MADERIA SCHOOL

Location: 8328 GEORGETOWN PIKE

General Stream Information:

Stream Name: DIFFICULT RUN, UT

Topographic Map (attach copy): _____

Basin: POT Section: 8 Class: III Special Standards: NONE

Are the standards for this stream violated due to natural causes? (Y/N) N

Is this stream correctly classified? (Y/N) Y

If "N", what is the correct classification? -

Additional Discharges Information:

Is there a discharger within 3 miles upstream of the proposal? (Y/N) N

Does antidegradation apply to this analysis? (Y/N) N* (WAS NOT APPLIED IN 4/8/92 MODEL) IN FIRST SEGMENT

Any dams in stream section being modeled? (Y/N) N

Notes:

Inspected by AJV + LAK Date 10/15/97 Region NRO

MADERIA SC

# STREAM INSPECTION REPORT FORM

OUTFALL 001 TO DIFFICULT RUN

(Fill In This Page for Each Segment to be Modeled)

Specific Stream Information From Field Inspection: Segment Number 1

Reason form Defining Segment: Tributary at End ✓ Physical Change at End ____
Discharge at End ____ End of Model ____

Length of Segment (mi.) 0.1

Estimated Average Width of Section (ft.) 0.5

Estimated Average Depth of Section (ft.) in Stream Center 0.2

Estimated Average Velocity of Section (ft/sec) 0.8

Estimated Flow in the Segment (MGD) .0496

General Type of Cross Section in Segment: Rectangular ____ Triangular ____ Deep Narrow U ____ Wide Shallow Arc ____ Irregular ✓ No Defined Channel ____

General Channel Characteristics of Segment:
Mostly Straight ✓ Moderately Meandering ____ Severely Meandering ____ No Defined Channel ____

Does the stream have a pool and riffle character? (Y/N) Y
If "Y" % of length that is pools — Average depth of pools (ft) —
% of length that is riffles 100% Average depth of riffles (ft) 0.2

Bottom: Sand ____ Silt ____ Gravel ____ Small Rock ____ Large Rock ✓ 50% Boulders ✓ 50%

Sludge Deposits: None ✓ Trace ____ Light ____ Heavy ____

Plants: Rooted: None ✓ Trace ____ Light ____ Heavy ____

Algae: None ✓ Film on Edges Only ____ Film on Entire Bottom ____

Does the water have an evident green color? (Y/N) N

Tributary: (Fill in if a tributary enters at the end of the segment)

Tributary Name: DIFFICULT RUN

Width (ft) 20' Depth (ft) 0.5 Estimated Flow (MGD) 1.9

Any evident Water Quality problems in the Trib.? (Y/N) N

If "Y", explain: ____

Discharges: (Fill in if a discharge enters at the end of the segment)

Discharge Name: N/A

Any evident problems caused by this discharge? (Y/N) ____

If "Y", explain: ____

REGIONAL MODELING SYSTEM

MADERIA SC

PAGE 3a

# DATA PREPARATION WORKSHEET

OUTFALL 001 TO DIFFICULT RUN SEG #1

(This Page is needed for Each Separate Segment being Modeled)

The first segment starts at the discharge being modeled and segment ends are defined according to the field inspection. Normally a distance of 3 to 5 miles is sufficient for a single discharge model. Dilution by a major tributary is often sufficient to allow the model to be ended. You should, however, inspect sufficient stream length to allow you to increase the number of segments or total model length if the model shows that the critical area is outside your initial estimates. This will allow the addition of segments and the preparation of a new data set without the necessity to reinspect the stream. As a general guideline, the higher the percentage the discharge is of the total stream. As a general guideline, the higher the percentage the discharge is of the total stream flow the longer the distance you will have to model. Ten miles should suffice for practically all situations.

Segment Definition Code: 1

Reasons for Defining a Segment:
- 1 = A Tributary Enters at the Segment End
- 2 = A Significant Physical Change Occurs at Segment End
- 3 = Another Discharge Enters at Segment End
- 4 = The Model Ends

Length of Segment (Mi.): 0.1

Based on the stream characteristics you observed, use your judgement and the flow ratio below to estimate the segment's physical characteristics at the 7Q10 flow condition. Note that the model checks to see if cross sectional area times velocity is equal to the flow (V=QA). It checks to see if the drainage are increases in the downstream direction. You will run into trouble if the estimates you make are unreasonable.

(a): Enter Flow Estimated During Inspection (MGD): .0496

(b): Enter 7Q10 at Model Start <Include Discharge> (MGD):

(c): Calculate the Flow Ratio (a/b):

Estimated 7Q10 Width (Ft.): .5

Estimated 7Q10 Depth (Ft.): .2

Estimated 7Q10 Velocity (Ft./sec.): .8

Continuity Check:

(a): Multiply: Width x Depth x Velocity x .6463: .051704

(b): Enter 7Q10 at Model Start <Include Discharge> (MGD): .0496

If the two numbers above differ by such, you have made some sort of error. Review your data and revise you estimates.

Drainage Area at the Beginning of This Segment (Sq.Mi.): 0.75

Drainage Area at the End of This Segment (Sq.Mi.): 1.0

(Omit the drainage area of any tributaries that are included in this segment under the "Tributary at End" section below).

Elevation at the Beginning of This Segment (Ft.): 130

Elevation at the End of This Segment (Ft.): 70

The following data is based on the field inspection and you should estimate what the overall "average" segment will look like at the 7Q flow condition. You enter the number code that best describes what you saw for this segment.

Type of Cross Section: 5

1 = Rectangular; 2 = Triangular; 3 = Deep Narrow U; 4 = Wide Shallow Arc; 5 = Irregular; 6 = No Defined Channel

MADERIA SC

# STREAM INSPECTION REPORT FORM

DIFFICULT RUN TO POTOMAC RIVER

(Fill In This Page for Each Segment to be Modeled)

Specific Stream Information From Field Inspection: Segment Number 2

Reason form Defining Segment: Tributary at End ✓ Physical Change at End ____
Discharge at End ____ End of Model ____

Length of Segment (mi.) 0.3

Estimated Average Width of Section (ft.) 20.

Estimated Average Depth of Section (ft.) in Stream Center 0.5

Estimated Average Velocity of Section (ft/sec) 0.3

Estimated Flow in the Segment (MGD) 1.9

General Type of Cross Section in Segment: Rectangular ____ Triangular ____ Deep Narrow U ____ Wide Shallow Arc ✓
Irregular ____ No Defined Channel ____

General Channel Characteristics of Segment:
Mostly Straight ____ Moderately Meandering ✓ Severely Meandering ____ No Defined Channel ____

Does the stream have a pool and riffle character? (Y/N) Y
If "Y" % of length that is pools 50 Average depth of pools (ft) .75
% of length that is riffles 50 Average depth of riffles (ft) .25

Bottom: Sand ____ Silt ____ Gravel ____ Small Rock ____ Large Rock ✓ Boulders ____

Sludge Deposits: None ✓ Trace ____ Light ____ Heavy ____

Plants: Rooted: None ✓ Trace ____ Light ____ Heavy ____

Algae: None ✓ Film on Edges Only ____ Film on Entire Bottom ____

Does the water have an evident green color? (Y/N) N

Tributary: (Fill in if a tributary enters at the end of the segment)

Tributary Name: POTOMAC RIVER

Width (ft) 300 Depth (ft) 4 Estimated Flow (MGD) 410

Any evident Water Quality problems in the Trib.? (Y/N) N

If "Y", explain: ____

Discharges: (Fill in if a discharge enters at the end of the segment)

Discharge Name: N/A

Any evident problems caused by this discharge? (Y/N) ____

If "Y", explain: ____

DATA PREPARATION WORKSHEET DIFFICULT RUN TO POTOMAC RIVER

(This Page is needed for Each Separate Segment being Modeled) SEG #2

The first segment starts at the discharge being modeled and segment ends are defined according to the field inspection. Normally a distance of 3 to 5 miles is sufficient for a single discharge model. Dilution by a major tributary is often sufficient to allow the model to be ended. You should, however, inspect sufficient stream length to allow you to increase the number of segments or total model length if the model shows that the critical area is outside your initial estimates. This will allow the addition of segments and the preparation of a new data set without the necessity to reinspect the stream. As a general guideline, the higher the percentage the discharge is of the total stream. As a general guideline, the higher the percentage the discharge is of the total stream flow the longer the distance you will have to model. Ten miles should suffice for practically all situations.

Segment Definition Code: 1

Reasons for Defining a Segment:
- 1 = A Tributary Enters at the Segment End
- 2 = A Significant Physical Change Occurs at Segment End
- 3 = Another Discharge Enters at Segment End
- 4 = The Model Ends

Length of Segment (Mi.): 0.3

Based on the stream characteristics you observed, use your judgement and the flow ratio below to estimate the segment's physical characteristics at the 7Q10 flow condition. Note that the model checks to see if cross sectional area times velocity is equal to the flow (V=QA). It checks to see if the drainage are increases in the downstream direction. You will run into trouble if the estimates you make are unreasonable.

(a): Enter Flow Estimated During Inspection (MGD) 1.9
(b): Enter 7Q10 at Model Start <Include Discharge> (MGD) _____
(c): Calculate the Flow Ratio (a/b) _____

Estimated 7Q10 Width (Ft.) 20
Estimated 7Q10 Depth (Ft.) .5
Estimated 7Q10 Velocity (Ft./sec.) .3

Continuity Check:
(a): Multiply: Width x Depth x Velocity x .6463 1.9389
(b): Enter 7Q10 at Model Start <Include Discharge> (MGD) 1.9

If the two numbers above differ by such, you have made some sort of error. Review your data and revise you estimates.

Drainage Area at the Beginning of This Segment (Sq.Mi.) 58.18
Drainage Area at the End of This Segment (Sq.Mi.) 60

(Omit the drainage area of any tributaries that are included in this segment under the "Tributary at End" section below).

Elevation at the Beginning of This Segment (Ft.) 70
Elevation at the End of This Segment (Ft.) 60

The following data is based on the field inspection and you should estimate what the overall "average" segment will look like at the 7Q flow condition. You enter the number code that best describes what you saw for this segment.

Type of Cross Section: 4

1 = Rectangular; 2 = Triangular; 3 = Deep Narrow U; 4 = Wide Shallow Arc; 5 = Irregular; 6 = No Defined Channel

MADEIRA SC

# STREAM INSPECTION REPORT FORM

(Fill In This Page for Each Segment to be Modeled)

Specific Stream Information From Field Inspection: Segment Number 3 POTOMAC RIVER 5 MI

Reason form Defining Segment: Tributary at End ____ Physical Change at End ____
Discharge at End ____ End of Model ✓

Length of Segment (mi.) 5

Estimated Average Width of Section (ft.) 300

Estimated Average Depth of Section (ft.) in Stream Center 4 (BOTTOM OF GREAT FALLS)

Estimated Average Velocity of Section (ft/sec) .55

Estimated Flow in the Segment (MGD) 410

General Type of Cross Section in Segment: Rectangular ✓ Triangular ____ Deep Narrow U ____ Wide Shallow Arc ____ Irregular ____ No Defined Channel ____

General Channel Characteristics of Segment:
Mostly Straight ____ Moderately Meandering ✓ Severely Meandering ____ No Defined Channel ____

Does the stream have a pool and riffle character? (Y/N) N
If "Y" % of length that is pools — Average depth of pools (ft) —
% of length that is riffles — Average depth of riffles (ft) —

Bottom: Sand ____ Slit ____ Gravel ____ Small Rock ✓ Large Rock ____ Boulders ____

Sludge Deposits: None ✓ Trace ____ Light ____ Heavy ____

Plants: Rooted: None ✓ Trace ____ Light ____ Heavy ____

Algae: None ✓ Film on Edges Only ____ Film on Entire Bottom ____

Does the water have an evident green color? (Y/N) N

Tributary: (Fill in if a tributary enters at the end of the segment)

Tributary Name: N/A

Width (ft) ____ Depth (ft) ____ Estimated Flow (MGD) ____

Any evident Water Quality problems in the Trib.? (Y/N) ____

If "Y", explain: ____

Discharges: (Fill in if a discharge enters at the end of the segment)

Discharge Name: N/A

Any evident problems caused by this discharge? (Y/N) ____

If "Y", explain: ____

REGIONAL MODELING SYSTEM MADERIA SC PAGE 3C

# DATA PREPARATION WORKSHEET POTOMAC RIVER 5 MI

(This Page is needed for Each Separate Segment being Modeled) SEG#3

The first segment starts at the discharge being modeled and segment ends are defined according to the field inspection. Normally a distance of 3 to 5 miles is sufficient for a single discharge model. Dilution by a major tributary is often sufficient to allow the model to be ended. You should, however, inspect sufficient stream length to allow you to increase the number of segments or total model length if the model shows that the critical area is outside your initial estimates. This will allow the addition of segments and the preparation of a new data set without the necessity to reinspect the stream. As a general guideline, the higher the percentage the discharge is of the total stream. As a general guideline, the higher the percentage the discharge is of the total stream flow the longer the distance you will have to model. Ten miles should suffice for practically all situations.

Segment Definition Code: 4

Reasons for Defining a Segment:
- 1 = A Tributary Enters at the Segment End
- 2 = A Significant Physical Change Occurs at Segment End
- 3 = Another Discharge Enters at Segment End
- 4 = The Model Ends

Length of Segment (Mi.): 5

Based on the stream characteristics you observed, use your judgement and the flow ratio below to estimate the segment's physical characteristics at the 7Q10 flow condition. Note that the model checks to see if cross sectional area times velocity is equal to the flow (V=QA). It checks to see if the drainage are increases in the downstream direction. You will run into trouble if the estimates you make are unreasonable.

(a): Enter Flow Estimated During Inspection (MGD) 410
(b): Enter 7Q10 at Model Start <Include Discharge> (MGD) _____
(c): Calculate the Flow Ratio (a/b) _____

Estimated 7Q10 Width (Ft.) 300
Estimated 7Q10 Depth (Ft.) 4
Estimated 7Q10 Velocity (Ft./sec.) .55

Continuity Check:
(a): Multiply: Width x Depth x Velocity x .6463 426.56
(b): Enter 7Q10 at Model Start <Include Discharge> (MGD) 410

If the two numbers above differ by such, you have made some sort of error. Review your data and revise you estimates.

Drainage Area at the Beginning of This Segment (Sq.Mi.) 11494
Drainage Area at the End of This Segment (Sq.Mi.) 11560

(Omit the drainage area of any tributaries that are included in this segment under the "Tributary at End" section below).

Elevation at the Beginning of This Segment (Ft.) 60
Elevation at the End of This Segment (Ft.) 50

The following data is based on the field inspection and you should estimate what the overall "average" segment will look like at the 7Q flow condition. You enter the number code that best describes what you saw for this segment.

Type of Cross Section: 1

1 = Rectangular; 2 = Triangular; 3 = Deep Narrow U; 4 = Wide Shallow Arc; 5 = Irregular; 6 = No Defined Channel

# DATA PREPARATION WORKSHEET

(This Page is Needed Once for each Model)

Use this form to assist in the preparation of the model input data. The form is arranged so that the data appears in the order needed by the model. Once the form is complete, you may input the data for a model run by simply entering the numbers and other data that you have put in the right hand column. There is some guidance provided here, but for detailed guidance refer to the manual or call headquarters for assistance.

Some of the input data are character, such as names; some are codes, such as "Y", "N" kor "3"; and some are actual numeric data such as "5.6". Be careful to enter the correct item called for. Some of the lines below may be blank depending on choices. Leave them blank and do not input data for blank lines when running the model. Miscellaneous items that are not in the right most column are intermediate guidelines, not input data.

| | |
|---|---|
| Site Inspection Performed? (Y/N) 10/15/97 | Y |
| Name of Receiving Stream | DIFFICULT RUN, VT |
| River Basin | POTOMAC |
| Section | 08 |
| Classification | III |
| Are Standards Violated Due to Natural Causes? (Y/N) | N |
| Class and Standards Appropriate for the Stream? (Y/N) | Y |
| Is there a Dam in the Reach to be Modeled? (Y/N) | N |
| Is There a Discharge Within 3 Miles of Model Start? (Y/N) | N |
| If "Y": Flow of Upstream Discharge (MGD) | - |
| BOD5 at Model Start (Mg/l) | - |
| TKN at Model Start (Mg/l) | - |
| D.O. at Model Start (Mg/l) | - |
| Name of Discharge Being Modeled | MADERIA SC |
| Proposed Flow (MGD) | .0495 |
| Proposed BOD (Mg/l) | 30 |
| Proposed TKN (Mg/l) | 3.75 |
| Proposed D.O. Start (Mg/l) | 6. |
| Number of Segments to be Modeled (Determined during your field inspection and based on the physical characteristics of the stream of the stream. See "Reason for Defining Segment" on Page 2) | 3 |
| 7Q Estimation Method Code (Two methods are provided: 1 = Drainage Area Comparison; 2 = Flow Comparison You may compare drainage areas or observed flows at the model site with a gauge). | 1 |
| Name of Gauge Used to Estimate 7Q10 | 57.9 |
| If Method 1: Gauge Drainage Area (Sq.Mi.) | 1.87 |
| Gauge 7Q10 (MGD) | 58.18 |
| Drainage Area at Discharge (Sq.Mi.) | - |
| If Method 2: Gauge 7Q10 (MGD) | - |
| Observed Flow at Gauge (MGD) | - |
| Observed Flow at Discharge (Sq.Mi.) | |
| Is the Stream a Dry Ditch? (Y/N) | N |
| Does Antidegradation Apply? (Y/N) | N |
| Allocation Temperature for the Model (°C) (Obtain a STORET retrieval for the nearest monitoring station to the discharge. Enter the 98th percentile temperature of the STORET data for the period being modeled.) | 25 |

| Table 5-1: Difficult Run Wasteload Allocation for VPDES Permitted Facilities for *E. coli* Bacteria | | | | | |
|---|---|---|---|---|---|
| **Permit Number** | **Facility Name** | **Facility Type** | **Design Flow (MGD)** | **Effluent Limit (cfu/100ml)** | **Wasteload Allocation (cfu/year)** |
| VA0024121 | The Madeira School | Municipal | 0.0495 | 126 | 8.62E+10 |
| Existing WLA | | | 0.0495 | 126 | 8.62E+10 |
| Future Growth Scenario: 2 x Existing WLA | | | 0.0990 | 126 | 1.72E+11 |
| Future Growth Scenario: 5 x Existing WLA* | | | 0.2475 | 126 | 4.31E+11 |

*Future growth scenario used in the TMDL

Benthic TMDL – WLA:

| Table 7-1: Point Source Wasteload Allocations for Difficult Run | | | | |
|---|---|---|---|---|
| **Permit No** | **Facility Name** | **TSS Load (kg/day)** | **Annual Sediment Loading (ton/year)** | **Percent Reduction** |
| VA0024121 | The Madeira School | 5.6 | 2.25 | - |
| **Current Allocated Wasteload for the Point Source** | | | 2.25 | - |
| **Expansion for Future Growth (5X WLA)** | | | 11.3 | - |
| **Total Allocated Wasteload for the Point Source** | | | **11.3** | - |

Public Notice – Environmental Permit

PURPOSE OF NOTICE: To seek public comment on a draft permit from the Department of Environmental Quality that will allow the release of treated wastewater into a water body in Fairfax County, Virginia.

PUBLIC COMMENT PERIOD: January 9, 2014 to February 7, 2014

PERMIT NAME: Virginia Pollutant Discharge Elimination System Permit – Wastewater issued by DEQ, under the authority of the State Water Control Board

APPLICANT NAME, ADDRESS AND PERMIT NUMBER: The Madeira School, Inc.
8328 Georgetown Pike, McLean, VA 22102
VA0024121

NAME AND ADDRESS OF FACILITY: The Madeira School STP
8328 Georgetown Pike, McLean, VA 22102

PROJECT DESCRIPTION: The Madeira School, Inc. has applied for reissuance of a permit for the private Madeira School Sewage Treatment Plant The applicant proposes to release treated sewage wastewaters from this private operation at a rate of 0.0495 million gallons per day into an unnamed tributary of Difficult Run in Fairfax County in the Potomac River Watershed. A watershed is the land area drained by a river and its incoming streams. Sludge from the treatment process will be disposed of by transfer to another sewage treatment plant operated by the Upper Occoquan Service Authority (UOSA; VA0024988). The permit will limit the following pollutants to amounts that protect water quality: pH, biochemical oxygen demand-5 day, total dissolved solids, dissolved oxygen, ammonia as nitrogen, *E. coli* bacteria, Total Nitrogen, and Total Phosphorus. Monitoring will be required for total Kjeldahl nitrogen, nitrate and nitrite as nitrogen, and oil and grease.

This facility is subject to the requirements of 9 VAC 25-820 and has registered for coverage under the General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Watershed in Virginia.

HOW TO COMMENT AND/OR REQUEST A PUBLIC HEARING: DEQ accepts comments and requests for public hearing by hand-delivery, e-mail, fax or postal mail. All comments and requests must be in writing and be received by DEQ during the comment period. Submittals must include the names, mailing addresses and telephone numbers of the commenter/requester and of all persons represented by the commenter/requester. A request for public hearing must also include: 1) The reason why a public hearing is requested. 2) A brief, informal statement regarding the nature and extent of the interest of the requester or of those represented by the requester, including how and to what extent such interest would be directly and adversely affected by the permit. 3) Specific references, where possible, to terms and conditions of the permit with suggested revisions. A public hearing may be held, including another comment period, if public response is significant, based on individual requests for a public hearing, and there are substantial, disputed issues relevant to the permit.

CONTACT FOR PUBLIC COMMENTS, DOCUMENT REQUESTS AND ADDITIONAL INFORMATION: The public may review the draft permit and application at the DEQ-Northern Regional Office by appointment, or may request electronic copies of the draft permit and fact sheet.
Name: Anna T. Westernik
Address: DEQ-Northern Regional Office, 13901 Crown Court, Woodbridge, VA 22193
Phone: (703) 583-3837 E-mail: anna.westernik@deq.virginia.gov Fax: (703) 583-3821

**Attachment 13**